Journal of the Royal Society of Arts

NO. 5045 APRIL 1960 VOL. CVIII

FORTHCOMING MEETINGS

WEDNESDAY, 30TH MARCH, at 2.30 p.m. '*The Structure and Organization of the Transport System*', by Gilbert J. Ponsonby, M.A., Reader in Commerce, London School of Economics and Political Science. The Rt. Honble. Lord Chesham, Joint Parliamentary Secretary, Ministry of Transport, in the Chair.

WEDNESDAY, 6TH APRIL, at 2.30 p.m. '*The Hovercraft and its Place in the Transport System*', by Christopher Cockerell, M.A. R. A. Shaw, O.B.E., M.A., F.R.Ae.S., Assistant Director, Aircraft Research, Ministry of Aviation, in the Chair. (The paper will be illustrated with a film.)

WEDNESDAY, 27TH APRIL, at 2.30 p.m. PETER LE NEVE FOSTER LECTURE. '*The Life and Work of Daniel Defoe*', by Bonamy Dobrée, O.B.E., M.A., formerly Professor of English Literature, University of Leeds. John Robert Moore, A.M., Ph.D., Professor of English, University of Indiana, in the Chair.

WEDNESDAY, 4TH MAY, at 2.30 p.m. '*Problems, Future Development and Prospects of the Internal System of Transport*', by D. L. Munby, M.A., Reader in Economics and Organization of Transport, University of Oxford.

MONDAY, 9TH MAY, at 6 p.m. The first of three CANTOR LECTURES on 'Energy', entitled '*The Generation of Power*', by J. M. Kay, M.A., Ph.D., M.I.Mech.E., Professor of Nuclear Power, Imperial College of Science and Technology.

TUESDAY, 10TH MAY, at 5.15 p.m. COMMONWEALTH SECTION. SIR GEORGE BIRDWOOD MEMORIAL LECTURE. '*The Pathans*', by Sir Olaf Caroe, K.C.S.I., K.C.I.E. His Excellency the High Commissioner for Pakistan in the Chair. (Tea will be served in the Library from 4.30 p.m.)

WEDNESDAY, 11TH MAY, at 2.30 p.m. Arrangements are being made for a paper on '*Problems and Future Development of the Shipping Industry*'.

MONDAY, 16TH MAY, at 6 p.m. The second of three CANTOR LECTURES on 'Energy', entitled '*The Transmission of Power*', by F. H. S. Brown, M.I.Mech.E., M.I.E.E., Member for Engineering, Central Electricity Generating Board.

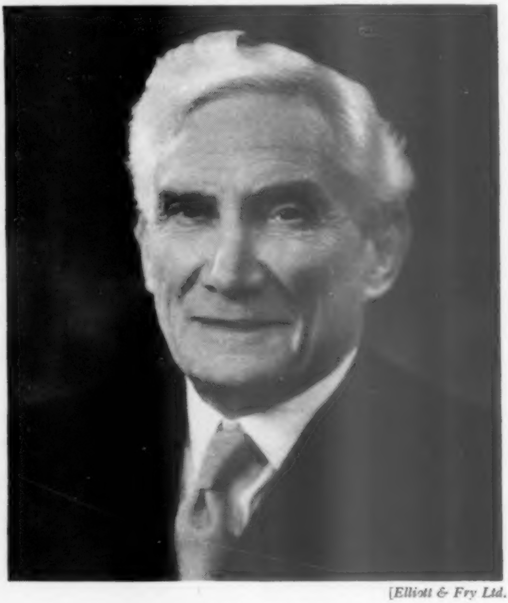
MONDAY, 23RD MAY, at 6 p.m. The last of three CANTOR LECTURES on 'Energy', entitled '*The Retail Distribution of Electricity*', by C. Robertson King, C.B.E., Chairman, The Electricity Council.

WEDNESDAY, 25TH MAY, at 2.30 p.m. '*The Problems and Prospects of Air Transport*', by Peter A. Masefield, M.A., F.R.Ae.S., Managing Director, Bristol Aircraft Ltd. Sir George Edwards, Managing Director, Vickers-Armstrong (Aircraft) Ltd., and a Vice-President of the Society, in the Chair.

MONDAY, 26TH MAY, at 5.15 p.m. COMMONWEALTH SECTION. HENRY MORLEY LECTURE. '*Recent Developments in Fiji*', by Sir Alan Burns, G.C.M.G. The Right Honble. the Earl of Perth, P.C., Minister of State for Colonial Affairs, in the Chair. (Tea will be served in the Library from 4.30 p.m.)

Fellows are entitled to attend any of the Society's meetings without tickets (except where otherwise stated), and may also bring two guests. When they cannot accompany their guests, Fellows may give them special passes, books of which can be obtained on application to the Secretary. Official representatives of Companies in association with the Society may also attend with one guest.

DEATH OF SIR EDWARD CROWE



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With great regret we record the death, in Cairo on 8th March, of Sir Edward Crowe, K.C.M.G. With the exception of Her Majesty the Queen, he was the

only surviving past President of the Royal Society of Arts, being elected in July, 1942, in succession to the Duke of Connaught, and he held this office, together with that of Chairman of Council (to which he had been elected in 1941) until July, 1943, when the then Princess Elizabeth succeeded him. Sir Edward had been made a Life Fellow and Vice-President of the Society in 1937, and held the latter office at the time of his death. He was 82.

Edward Thomas Frederick Crowe was educated at Bedford School, and followed his father into the Consular Service, being appointed student interpreter in Japan in 1897. He served in different parts of that country until 1918, when he moved to Tokyo to become Commercial Counsellor at the Embassy. Six years later he was seconded to London as Director of the Foreign Division of the Department of Overseas Trade, succeeding Sir William Clark as Comptroller-General of the Department in 1928. Crowe's long experience of Japan, and his admiration for its people and traditions, were reflected during his years as Comptroller-General in a vigorous and sustained promotion of this country's commercial relations with the Far East. He also did much to foster the development of the British Industries Fair, which grew to truly international stature under his direction.

Crowe's interest in exhibitions—one aspect of that versatility of taste which made his association with this Society so happy—found expression also in his work as Vice-President of the International Exhibitions Bureau in Paris from 1928 to 1937 (the year of his retirement) and as Vice-President, during the same period, of the Board of Governors of the Imperial Institute. A former member of Lord Gorrell's Committee on Art and Industry, he took great personal and official pleasure in the extent to which that Committee's recommendations were fulfilled by the Exhibition of British Art in Industry organized by this Society in conjunction with the Royal Academy at Burlington House in 1935. Three years later he had the satisfaction of presiding at the meeting in the Society's house when the late J. A. Milne put that exhibition and its results into perspective. This was one of the earliest of many apt contributions made by Sir Edward, on a characteristically wide range of subjects, to the Society's proceedings.

Only less important than his leadership of the whole Society, however, was Sir Edward's self-identification with its work for the education of young people. He was Chairman of the Examinations Committee for sixteen years (1942–58), a period first of adaptation to wartime difficulties and subsequently of steady expansion and success—much of which is to be attributed to his grasp and energy. For almost the same length of time he served on the Industrial Art Bursaries Board, and took part in the growth of its activities also. He made an admirable Chairman of juries in several sections of the annual Bursaries Competition—most recently, in 1959, of the Women's Fashion Section.

Though Sir Edward's retirement from the Department of Overseas Trade by no means saw the end of his public service—he was, for example, a member of Lord Fleming's Committee on Public Schools from 1942–4—he thereafter assumed a number of business responsibilities. He was Chairman of Croda Ltd., and a Director of the English Electric Company Ltd., W. T. Henley's Telegraph

Works Company Ltd., and Marconi's Wireless Telegraph Company. In his leisure he gave valuable support to those bodies in particular whose activities evoked memories of his earlier life—the Old Bedfordian Club, the Japan Society of London, and the Japan Association, of which he was President in 1951–2. He was awarded the Japanese Order of the Sacred Treasure, First Class, in 1955. He had been knighted in 1922, and was appointed K.C.M.G. in 1930.

The following eulogy has been written by Sir Harry Lindsay, K.C.I.E., C.B.E., a Vice-President of the Society.

As one gets on in years, the number of one's 'seniors' naturally tends to contract—seniors not only in age but also in the official sense. I have always counted myself very fortunate that, after retiring from service in and for India, I was appointed in 1934 to a post which brought me into close touch with Sir Edward Crowe, my senior not only in age but also in the official hierarchy of British Civil Servants.

I had met him before many times when he was Comptroller-General of the Department of Overseas Trade and I was Indian Trade Commissioner in London. But from 1934 our relationship became closer still, and I found him no less courteous and effective a 'bara sahib' than he had been as friend and counsellor.

He had a wonderful way with him. For him, the intricacies of officialdom, its distant objectives, subtle thoughts and devious ways, held no terrors; it was a game which his own innate commonsense and deep sympathies enabled him to play with artless grace and consummate skill. But it was above all his sense of human neighbourliness, his 'touchability', if one may coin the term, which endeared him to all with whom he came into contact.

As a Member of Council of the Royal Society of Arts, then its President and Chairman of Council, and finally as Vice-President and an ordinary Member both of the Council and of its Finance and General Purposes Committee, he richly fulfilled all our expectations of him. And, in some ways, during this closing period of his life he was perhaps at his happiest and most serene. He had given so much of himself to his official duties and contacts, and later to his business interests. At the Royal Society of Arts he was his gay, relaxed and spontaneous self. Truly the Society still owes to him more than it could ever repay; with us who are left his memory will never fade.

FIRST ANNUAL RECEPTION

The President, His Royal Highness the Duke of Edinburgh, attended the First Annual Reception of the Society, which was held at the Society's House on the evening of 3rd March. The Duke of Edinburgh, attended by Mr. James Orr, was received by Mr. Oswald Milne, Chairman of Council, and Mrs. Milne, with the Mayor and Mayoress of Westminster; and after greeting Members of Council and their ladies in the library, he proceeded through each room, mingling with the general company of the Society's guests and Fellows, a number of

whom were presented to him. The President spent some time in inspecting the small exhibition (described on page 369 of this issue) which had been arranged to commemorate that held under the Society's aegis in 1760, and he also watched a short film show, including extracts from *Royal River*, an account of the Queen's progress, with His Royal Highness, up the St. Lawrence River in H.M.Y. *Britannia* last year. Later in the evening, the Duke of Edinburgh listened to the second of two recitals given by a quintet of the Musica da Camera in the Lecture Hall.

Over 400 Fellows and their guests were present at the Reception. Some of them travelled a long way for the purpose, including, in particular, a recently elected American Fellow, Mr. Joseph V. Ferriot, and his wife, who had come from Ohio especially to attend this function. The official guests included leading representatives of other societies and institutions, amongst whom were: the Presidents of the Royal Society, the Society of Antiquaries, the Royal Academy, the Linnean Society of London, the British Association for the Advancement of Science, the Royal Institute of British Architects, the Royal Photographic Society, the Royal Institution of Naval Architects, the Association of British Chambers of Commerce, the Federation of British Industries, the Design and Industries Association, and the National Union of Manufacturers; the Director of the City and Guilds of London Institute, and the Chairmen of the London County Council, the Institution of Civil Engineers, the Institute of Builders, the Architectural Association, the Institution of Mechanical Engineers, the Trades Union Congress, the Press Council, the National Research Development Corporation, the Council of Industrial Design, and the Building Centre.

The honour done to the Society by the Duke of Edinburgh's visit, and the general pleasure expressed at the evening's arrangements, encourage the Council to regard this first reception as a success in itself and a good auspice for similar functions in succeeding years.

EDMUND RICH MEMORIAL TRUST

The Council has gratefully accepted from Mrs. Edmund Rich the gift of £500, which she has made for the purpose of establishing a trust to endow a biennial lecture in memory of her late husband, a former Vice-President and Member of Council of the Society, and sometime Chief Education Officer to the London County Council. In giving this money, Mrs. Rich has informed the Council that she is fulfilling her husband's express desire, and in accordance therewith the lecture will be known as the Edmund Rich Memorial Lecture, and will be devoted in each case to some 'educational or kindred subject chosen by the Society'.

PAXTON MEMORIAL TRUST BURSARIES

In 1959 the Society offered the award of a Paxton Memorial Trust Bursary of £50 to assist a British student taking up horticulture as a career to study its practice in the United Kingdom or overseas. The funds for this Bursary

had been made available under the terms of the Paxton Memorial Trust, which was created in 1951 by the late Miss Violet Markham, C.H., to commemorate her grandfather, Sir Joseph Paxton (1801–65), the noted gardener, and designer of the Crystal Palace, and at one time a Member of this Society.

Eleven candidates submitted applications for the award, and the Council has decided that Mr. I. G. Walls and Mr. B. E. Steane should each receive a Bursary of £50. This decision to make two awards instead of the one intended is based upon the recommendation of an advisory committee, which considered that, whilst Mr. Walls was the outstanding candidate, Mr. Steane would also make excellent use of the opportunities offered by the Bursary.

Mr. Walls is employed in the County Advisory Service in Renfrewshire and Dumbartonshire under the control of the West of Scotland Agricultural College. He proposes to use his award in order to visit glass-house areas in Holland and England to study the economics of raising commercial crops under glass. Mr. Steane, who is a lecturer specializing in market garden crops at the Institute of Horticulture, Pershore, Worcs., intends visiting Holland to examine Dutch inspection schemes of vegetable seeds, to study the management and organization of co-operative markets (particularly with regard to packing standards and inspection systems) and to examine the inter-relationship of research advisory services and teaching.

The advisory committee appointed by the Council to judge the entries for this competition consisted of Sir Ernest Goodale (Chairman), the Earl of Radnor, Mr. P. E. Cross (a Fellow of the Society) and the Honble. Lewis Palmer. Mr. Palmer represented the Royal Horticultural Society, which provided valuable help in the organization of the competition.

BENJAMIN FRANKLIN FELLOWS

The list of elections printed in the report of the last meeting of Council (page 301) includes the names (marked with an asterisk) of forty-three Benjamin Franklin Fellows of the Society. It will be remembered that in the May, 1959, *Journal*, an announcement was made of the Council's intention to commemorate Benjamin Franklin's association with the Society by appointing a number of distinguished American citizens as 'Benjamin Franklin Fellows', and its decision that the members of the American committee charged with making the preliminary nominations in connection with this distinction should themselves be the first to receive it. Since those initial appointments the elections now announced are the first to have been made.

MEETING OF COUNCIL

A meeting of Council was held on Monday, 14th March. Present: Mr. Oswald P. Milne (in the Chair); Mrs. Mary Adams; Sir Hilary Blood; Lord Bossom; the Honble. G. C. H. Chubb; Mr. R. E. Dangerfield; Sir George

Edwards; Mr. Peter Le Neve Foster; Mr. Geoffrey de Freitas; Mr. E. Maxwell Fry; Mr. John Gloag; Sir Ernest Goodale; Dr. Stanley Gooding; Mr. Milner Gray; Dr. R. W. Holland; Mr. William Johnstone; Sir Harry Lindsay; Mr. F. A. Mercer; Lord Nathan; Mr. Paul Reilly; Sir Gilbert Rennie; Mr. A. R. N. Roberts; Sir Philip Southwell; Mr. G. E. Tonge; Mr. C. M. Vignoles; Mr. Hugh A. Warren and Sir Griffith Williams; with Dr. K. W. Luckhurst (Secretary), Mr. G. E. Mercer (Deputy Secretary), and Mr. J. S. Skidmore (Assistant Secretary).

ELECTIONS

The following candidates were duly elected Fellows of the Society (those whose names are marked with an asterisk were elected Benjamin Franklin Fellows):

*Abrams, Harry N., New York, N.Y., U.S.A.
Armstrong, Lt.-Col. William Barry Jeffares, B.A.(Eng.), Fleet, Hants.
Austen, Raymond, Seaford, Sussex.
Ball, Edmund Hugo, London.
*Barzun, Professor Jacques, A.B., Ph.D., New York, N.Y., U.S.A.
*Beilenson, Mrs. Edna, Mount Vernon, New York, U.S.A.
Bernat, Paul, Chestnut Hill, Mass., U.S.A.
*Bing, Rudolf, New York, N.Y., U.S.A.
Blease, Leslie, A.R.I.B.A., A.R.I.C.S., Sevenoaks, Kent.
*Block, Miss Maurine, Dallas, Texas, U.S.A.
Brandon-Jones, John, A.A.Dip., A.R.I.B.A., London.
*Breeskin, Dr. Adelyn Dohme, Baltimore, Maryland, U.S.A.
Brown, Gerald André Lucien, Ascot, Berks.
Bruce, John Robert, A.T.D., Middlesbrough, Yorks.
*Bryans, Henry Bussell, A.B., B.S., Philadelphia, Pa., U.S.A.
*Burdell, Edwin Sharp, A.M., Ph.D., Ankara, Turkey.
*Butterworth, James Ebert, B.S., Philadelphia, Pa., U.S.A.
Campbell, Brigadier Colin A., D.S.O., O.B.E., P.Eng., Woodbridge, Ontario, Canada.
Chambers, Michael John, London.
*Cheatham, Owen Robertson, LL.D., New York, N.Y., U.S.A.
Cohen, Lady (Herbert), London.
*Cooper, Basil Hubert, Moorestown, N.J., U.S.A.
*Cowles, Gardner, A.B., LL.D., New York, N.Y., U.S.A.
*Cunningham, Charles Crehore, Hartford, Connecticut, U.S.A.
*Davis, Miss Gladys Rockmore, New York, N.Y., U.S.A.
Dinsdale, Walter Arnold, Ph.D., B.Com., London.
*Distelhorst, Carl F., Orlando, Florida, U.S.A.
*Douglas, Donald Wills, B.S., Rolling Hills, California, U.S.A.
*Ensley, Grover William, New York, N.Y., U.S.A.
*Farrell, James A., Jr., New York, N.Y., U.S.A.
Frazer, James Oliver, B.Sc., Dip.Ed., Mansfield, Notts.
*Funston, George Keith, Greenwich, Connecticut, U.S.A.
Gettings, Jack, London.
*Gibson, Paul Emile, Chicago, Illinois, U.S.A.
Giles, Eric Leese, London.
Gordon, Raymond, Thames Ditton, Surrey.

Gray, Anton, Ph.D., B.Sc., Reading, Berks.
*Grimm, Peter, New York, N.Y., U.S.A.
Hancock, Charles Granville, M.A., London.
Hawes, Meredith William, A.R.C.A., A.R.W.S., Birmingham.
Hayzer, Charles, Romford, Essex.
*Hedges, William Saxby, Scarsdale, N.Y., U.S.A.
*Himmell, Samuel S., New York, N.Y., U.S.A.
*Hoadley, Professor Leigh, A.B., Ph.D., Cambridge, Mass., U.S.A.
Ho Fan, Hong Kong.
Hoie, Yook-Loon, Singapore.
Holmes, Professor Frank Wakefield, M.A., Wellington, New Zealand.
Hough, James Sellis, Folkestone, Kent.
*Irr, Henry Pitman, Baltimore, Md., U.S.A.
Jardine, Fergus, F.S.A.(Scot.), Glasgow.
*Johnston, Eric Allen, LL.D., Washington, D.C., U.S.A.
King, John Stuart Harry, Sutton-in-Ashfield, Notts.
*King, Kenneth Kendal, Denver, Colorado, U.S.A.
Lauritz, Paul, Hollywood, California, U.S.A.
*LePage, Wynn Laurence, Philadelphia, Pa., U.S.A.
Littlewood, Harry, Cape Town, South Africa.
Lock, Tom, Northants.
Longden, Henry Alfred, B.Sc., A.M.I.C.E., F.G.S., Woldingham, Surrey.
*Lowe, Mrs. Joe, New York, N.Y., U.S.A.
Mallory, Alec Leslie, A.R.I.B.A., Leeds.
Marley, Major Edwin Henry, M.B.E., T.D., F.C.A., St. Asaph, N. Wales.
Maxted, Horace Amedee, Ramsgate, Kent.
McGuinness, John, N.D.D., Leiston, Suffolk.
Millard, Raymond Spencer, Ph.D., M.I.C.E., Windsor, Berks.
*Mongan, Miss Agnes, Cambridge, Mass., U.S.A.
Morgan, Neville, Des.R.C.A., Sale, Cheshire.
*Mumford, Lawrence Quincy, Washington, D.C., U.S.A.
*Mumford, Lewis, Amenia, N.Y., U.S.A.
Mustoe, Gordon, Coventry.
*Nagel, Charles, St. Louis, Missouri, U.S.A.
Nuttall, Derek, Rossendale, Lancs.
Oppenheim, Sir Duncan Morris, London.
Ouvry, Romilly Southwood, B.A., London.
*Paley, William S., B.S., New York, N.Y., U.S.A.
Pember, Geoffrey, A.C.G.I., B.Sc., M.I.E.E., London.
Peterson, Miss Jane, New York, N.Y., U.S.A.
Polkinghorne, Michael Cumming, Crawley, Sussex.
Pollock, Sir George, Q.C., London.
Ratcliffe, John Nielsen, F.C.I.S., Oxhey, Herts.
Ratcliffe-Small, Derrick William, London.
Richardson, Alfred, Rhyl, Flintshire.
Richardson-Ellison, John MacCammond, M.A., LL.D., Melbourne, Australia.
*Roach, John Hendee, Long Island, N.Y., U.S.A.
Roberts, Clifford Ralph, A.T.D., London.
*Rolph, Samuel Wyman, Philadelphia, Pa., U.S.A.
Roy, Subrata, M.Sc., LL.B., Calcutta, India.
Samuels, Professor Leo Tolstoy, B.A., Ph.D., Salt Lake City, Utah, U.S.A.
Shepherd, Edward George, Huddersfield.
*Sherbourne, Major Everett C., Elizabeth, N.J., U.S.A.
*Smith, Gordon M., Buffalo, N.Y., U.S.A.

Smith, Percival Henry, Lusaka, N. Rhodesia.
*Smith, Walter Lewis, Jr., Philadelphia, Pa., U.S.A.
Stern, Miss Hanna, London.
Stirrat, Mrs. Jeannie Eleanor, M.B., Ch.B., D.P.M., Birmingham.
*Stone, Edward Durell, New York, N.Y., U.S.A.
Tanser, Robert William Pearson, Welling, Kent.
*Theobald, Adrian D., Peoria, Illinois, U.S.A.
Tolley, George, M.Sc., Ph.D., F.R.I.C., Wellington, Salop.
Tomblin, Norman Arthur Henry, London.
*Vander Ende, Gerrit P., Tacoma, Washington, U.S.A.
Vaughan-Morgan, Sir John Kenyon, Bt., M.P., London.
Vincent, Professor John Joseph, M.Sc., F.T.I., Manchester.
*Woodbridge, Charles Kingsley, B.S., New York, N.Y., U.S.A.

The following Companies were admitted into association with the Society:

J. H. Fenner & Company Ltd., Hull.
G. N. Haden & Sons Ltd., London.

ALBERT MEDAL FOR 1960

Preliminary consideration was given to the award of the Albert Medal for 1960.

EDMUND RICH MEMORIAL TRUST

It was agreed to accept an offer from Mrs. E. M. Rich to endow a trust in memory of her late husband, Edmund Rich, with the purpose of providing funds for a lecture on some educational or kindred subject. (See separate Notice on p. 299.)

PAXTON MEMORIAL TRUST BURSARIES

Paxton Memorial Trust Bursaries of £50 each were awarded to Mr. I. G. Walls and Mr. B. E. Steane. (See separate Notice on p. 299.)

ROYAL DRAWING SOCIETY'S COMPETITION

It was agreed that the Society should resume its former practice of offering the award of a bronze medal in connection with the Royal Drawing Society's annual competition, and Mr. William Johnstone was deputed to act with the President of the Royal Drawing Society in making the recommendation for this award.

EXAMINATIONS

It was reported that 54,251 entries had been received for the spring series of examinations, an increase of 10,306 over the corresponding 1959 figure.

H. E. ARMSTRONG MEMORIAL TRUST

Mr. Hugh A. Warren was appointed as the Council's representative on the H. E. Armstrong Memorial Trust in succession to the late Mr. A. C. Hartley.

CENTENARY OF RABINDRANATH TAGORE

It was agreed to accept an invitation extended by the Royal India, Pakistan and Ceylon Society to the Society to take part in organizing celebrations commemorative of the centenary of the birth of Rabindranath Tagore. The Chairman of Council and Sir Hilary Blood, Chairman, Commonwealth Section Committee, were appointed to represent the Society on the Committee to be set up for this purpose.

TERCENTENARY OF THE ROYAL SOCIETY

It was decided to send an address of congratulation to the Royal Society on the occasion of its tercentenary celebrations in July, 1960.

COMMONWEALTH TECHNICAL TRAINING WEEK

Mr. Hugh A. Warren was appointed as the Society's representative on the United Kingdom Committee of the Commonwealth Technical Training Week.

OTHER BUSINESS

A quantity of financial and other business was transacted.

INDUSTRIAL ART BURSARIES

1959 COMPETITION

At the request of the Council, the Industrial Art Bursaries Board again organized a competition in 1959. Bursaries, in most cases of £150 each, were offered in 17 different sections. These covered the following subjects: acrylic sheet ('Perspex'); carpets; domestic electrical appliances; domestic solid-fuel-burning appliances; dress textiles; electric-light fittings; flat glass decoration; footwear; furnishing textiles; furniture; laminated plastics; packaging; pottery; film, stage and television settings; typography; wall-paper, and women's fashion wear. The Sir Frank Warner Memorial Medal was also offered for the best design in the carpet, dress textiles, and furnishing textiles sections.

The competition was open to full-time or part-time students, between the ages of 17 and 30, of art, architectural, technical or other colleges or schools approved by the Society. In certain sections eligibility was extended to include young draughtsmen, clerks or other similar persons engaged in industry, whether or not they had had any previous art school training, provided that they were recommended by a responsible officer of the industry concerned as having sufficient ability to compete in a national competition. In all, 653 candidates from 81 schools and industrial establishments entered the competition; this compares with 495 candidates in 1958, 423 in 1957, and 412 in 1956, in which years the numbers of schools and industrial establishments represented were 80, 70, and 70 respectively.

Candidates were required both to undergo a set test, carried out under invigilation, and to submit examples of work, chosen from the work done by them in the ordinary course of their studies.

As in the past, the Council's purpose in arranging the competition was to enable successful candidates to enlarge their knowledge and experience by travel abroad and the study of foreign design, or in certain cases to obtain art training or industrial experience in this country. The success of the tours made by Bursary winners depends largely upon their meeting manufacturers and industrial designers in the countries visited, and in past years many people in this country have kindly given assistance by providing helpful introductions. In this connection the Bursaries Board would be grateful to hear from Fellows who may be able to help these students when the latter are abroad.

The Council desires to express its thanks to all those who have assisted and advised in the conduct of the competitions: particularly to the firms, organizations and individuals who generously subscribed towards the cost of the Bursaries, to the Juries for their voluntary services, and to the heads of those organizations entering candidates for their co-operation.

The Council, adopting the recommendations of the Industrial Art Bursaries Board based on the reports of the Juries, has awarded 34 Bursaries, amounting in value to £4,425. The following awards and commendations have been made in connection with the 17 sections included in the competition:

DOMESTIC ELECTRICAL APPLIANCES

Bursary (£150): *John Patterson** (Newcastle-upon-Tyne College of Art and Industrial Design: age 18)

Commended: Robert Hipkins (Birmingham College of Art and Crafts: age 19)

ELECTRIC-LIGHT FITTINGS

Bursary (£150): *George Murray* (Royal College of Art: age 21)

Commended: Kenneth Sadler (Royal College of Art: age 21)

DOMESTIC SOLID-FUEL-BURNING APPLIANCES

Bursary (£150): *David Lewis** (L.C.C. Central School of Arts and Crafts: age 20)

Commended: Peter Dawson (Newcastle-upon-Tyne College of Art and Industrial Design: age 19) and *Geoffrey Pickering* (Newcastle-upon-Tyne College of Art and Industrial Design: age 18)

CARPETS

Bursary (£150): *Roy Varndell* (Peel Park Technical College School of Art: age 21)

Commended: Jacqueline Hayler (Stockport School of Art: age 17), *Peter McGowan* (John Crossley & Sons Ltd., formerly at the Halifax School of Art: age 24), *Richard Millis* (Kidderminster College of Further Education: age 18) and *Sadie Williams* (Stockport School of Art: age 18)

DRESS TEXTILES

*Bursaries: Peggy Croot** (Brighton College of Art and Crafts: age 20), *Barbara Payze** (Hornsey College of Arts and Crafts: age 19) and *Rosalie Taylor** (South-West Essex Technical College and School of Art: age 19), £150 *each*, and *William Johnstone* (Scottish Woollen Technical College: age 21), £50.

Commended: Hilary Day (Hornsey College of Art: age 20), *Eunice Gough* (Manchester Regional College of Art: age 20), *Constance Pask* (West Sussex College of Art and Crafts: age 21), *Robert Russell* (Scottish Woollen Technical College: age 22), *Ann Thornton* (Leeds College of Art: age 19) and *Beatrice Tomlinson* (Peel Park Technical College School of Art: age 19)

FURNISHING TEXTILES

Bursaries: Doreen Andrews (Winchester School of Arts and Crafts: age 21), £150; *Howard Carter* (South-East Essex Technical College and School of Art: age 21), £125†

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* Also awarded Associate Membership of the Society.
† Supplementary Bursary from Owen Jones Memorial Trust Fund.

Commended: Mary Ellis (L.C.C. Central School of Arts and Crafts: age 21), *Paul Haines* (an evening school student at the Ealing Technical College and School of Art, employed in the Perivale design studio of A. Sanderson & Sons Ltd.: age 23), *Jennifer Horton* (Canterbury College of Art: age 21), *Wendy Ramshaw* (Newcastle-upon-Tyne College of Art and Industrial Design: age 20) and *James Vick* (an evening school student at the Ealing Technical College and School of Art, employed in the Uxbridge design studio of Sanderson's Fabrics Ltd.: age 25)

WOMEN'S FASHION WEAR

TALFO *Bursaries: James Wedge* (Royal College of Art: age 22), £200; *Sanda Cormack* (Royal College of Art: age 22), £150

Commended: Valerie Cutts (Newcastle-upon-Tyne College of Art and Industrial Design: age 18), *June Mackereth* (Newcastle-upon-Tyne College of Art and Industrial Design: age 17), *Susan Schaefli* (Kingston-upon-Thames School of Art: age 19) and *Heather Woodhall* (Leeds College of Art: age 19)

ACRYLIC SHEET ('PERSPEX')

Bursary (£150): *Brian Coysten** (L.C.C. Central School of Arts and Crafts: age 20)

Commended: Richard Cuttriss (Royal College of Art: age 25) and *Michael Durrant* (L.C.C. Central School of Arts and Crafts: age 19)

LAMINATED PLASTICS

Bursary (£150): *Margaret Hall* (Royal College of Art: age 23)

Commended: Barbara Austrin (South-East Essex Technical College and School of Art: age 20), *Louie Moore* (Bradford Regional College of Art: age 20), *Bernadette O'Donnell* (Bradford Regional College of Art: age 20), *Bruce Rowling* (Kingston-upon-Thames School of Art: age 19) and *Jane Stewart* (Winchester School of Arts and Crafts: age 21)

FILM, STAGE AND TELEVISION SETTINGS

Bursaries: Terence Andrews (B.B.C., formerly Royal College of Art: age 26), *David Lovett** (Wimbledon School of Art: age 20), *Barbara Pike*† (L.C.C. Central School of Arts and Crafts: age 21) and *Lionel Radford* (B.B.C., formerly L.C.C. Hammersmith College of Art and Building: age 27), £150 *each*

Commended: Richard Bayldon (Leicester College of Art: age 21), *Susan Davis* (Wimbledon School of Art: age 18), *Jill Gregory* (Wimbledon School of Art: age 20), *Andrée Welstead* (L.C.C. Central School of Arts and Crafts: age 23) and *Fred Whitehead* (Royal College of Art: age 22)

FOOTWEAR

Bursaries: Edward Lunn (Northampton School of Art: age 21) and *Mary Rycroft* (Leicester College of Art: age 23), £150 *each*

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* Also awarded Associate Membership of the Society.
† Supplementary Bursary from the Art Congress Studentship Trust Fund.

Commended: John Darlow (Northampton School of Art: age 19) and *Jill Morris* (Royal College of Art)

FLAT GLASS DECORATION

Bursaries: George Elliott (Royal College of Art: age 26) and *William Harris* (Royal College of Art: age 26), £75 *each*

Commended: Eric Burdon (Newcastle-upon-Tyne College of Art and Industrial Design: age 18)

FURNITURE

*Bursaries: Martin Payne** (High Wycombe College of Further Education: age 19), *Terence Poole* (Royal College of Art: age 24) and *John Willis** (Newcastle-upon-Tyne College of Art and Industrial Design: age 19), £150 *each*; *Norman Allanson** (Royal College of Art: age 19), *Michael Barnwell* (L.C.C. Central School of Arts and Crafts: age 21), *Norman Stocks* (High Wycombe College of Further Education: age 27) and *Raymond Wilkes* (Royal College of Art: age 24), £75 *each*

Commended: Lawrence Berry (Newcastle-upon-Tyne College of Art and Industrial Design: age 18), *James Fleming* (High Wycombe College of Further Education: age 21), *Elizabeth Goldfinger* (L.C.C. Central School of Arts and Crafts: age 23), *David Johns* (L.C.C. Central School of Arts and Crafts: age 24), *Robert Smart* (Edinburgh College of Art: age 27) and *Edward Talbot* (Newcastle-upon-Tyne College of Art and Industrial Design: age 19)

PACKAGING

Bursary (£150)*: John Drysdale** (Newcastle-upon-Tyne College of Art and Industrial Design: age 19)

Commended: Colin Barrett (Newcastle-upon-Tyne College of Art and Industrial Design: age 18), *Trevor Birch* (Leicester College of Art: age 18), *Edward Barnes* (Coventry College of Art: age 20), *Joseph Brown* (Newcastle-upon-Tyne College of Art and Industrial Design: age 23), *John Heritage* (Royal College of Art: age 24), *Thomas Jarratt* (Newcastle-upon-Tyne College of Art and Industrial Design: age 19) and *Chryssi Phylactou* (Bradford Regional College of Art: age 21)

POTTERY

Bursary (£150)*: Lesley Mackinnon* (Leeds College of Art: age 21)

Commended: Michael Cleaver (Stoke-on-Trent College of Art: age 21), *Angela Hughes* (L.C.C. Hammersmith College of Art and Building: age 22) and *Harry Sales* (Stoke-on-Trent College of Art: age 20)

TYPOGRAPHY

Bursary (£150)*: Charles Healey* (Leicester College of Art: age 27)

Commended: Brian Booth (Nottingham College of Art and Crafts: age 19),

* Also awarded Associate Membership of the Society.

Sylvia Sewell (Reigate and Redhill School of Art and Crafts: age 21) and *David Tudor* (Leicester College of Art: age 23)

George M. Whiley Bursaries: Andrée Welstead (L.C.C. Central School of Arts and Crafts: age 23), £100, and *Margaret Hall* (Royal College of Art: age 23), £50

The Sir Frank Warner Memorial Medal: Beatrice Tomlinson (Peel Park Technical College School of Art: age 19)

No awards were made in the Wall-paper Section.

Publication of Report

Full details of the 1959 competition are contained in the annual report which has just been published. This report includes particulars of the tests set in each section, the names of the winning and commended candidates, the reports and composition of the Juries, and a summary of the uses made of Bursaries in 1959 by previous Bursary winners. Illustrations of many of the winning designs, a number of which are reproduced on the following pages of this *Journal*, are also included. This year in addition the report contains a summary of the information deliberately gathered in 1959 about the subsequent careers of those students who won Bursaries in the thirteen competitions held between 1946 and 1958.

Copies of the report can be obtained on application to the Bursaries Officer.

Exhibition

An exhibition of the winning and commended designs submitted in the competition will be held at the Royal Society of Arts during the three weeks preceding Whitsun. The exhibition will be officially opened by Mr. Whitney Straight, C.B.E., M.C., D.F.C., Deputy Chairman, Rolls-Royce Limited, and a representative of the Minister of Education on the National Advisory Council on Art Education, on Tuesday, 17th May, at 12 noon, and will be open to the public from 2 p.m. on that date until Friday, 3rd June.

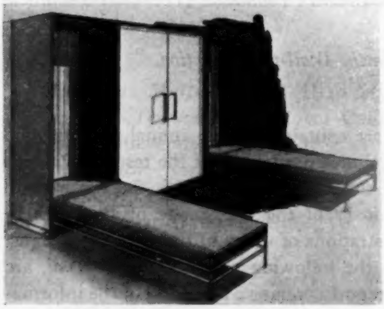
Special cards of admission will be required for the opening, and although it is expected that the majority of these cards must be issued to those who are directly concerned with the organization of the competition, a number will be available for other Fellows. Those Fellows who are interested should apply to the Bursaries Officer by the 10th May.

1960 COMPETITION

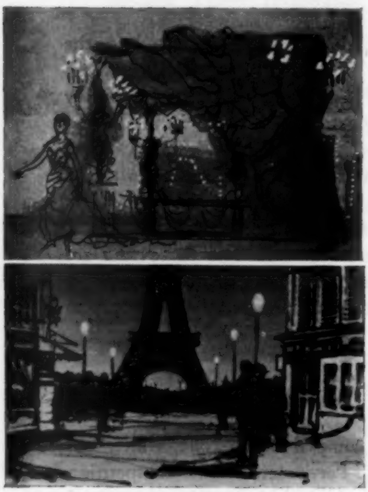
The Council has decided to hold a further competition in 1960, which will be organized on the same lines as that in 1959. Particulars of this competition will be published in July, and the list of sections to be included will be announced in the July issue of the *Journal*.

SOME OF THE DESIGNS

All the designs reproduced in these pages were submitted for the Set Tests. The captions are taken from the students' own descriptions

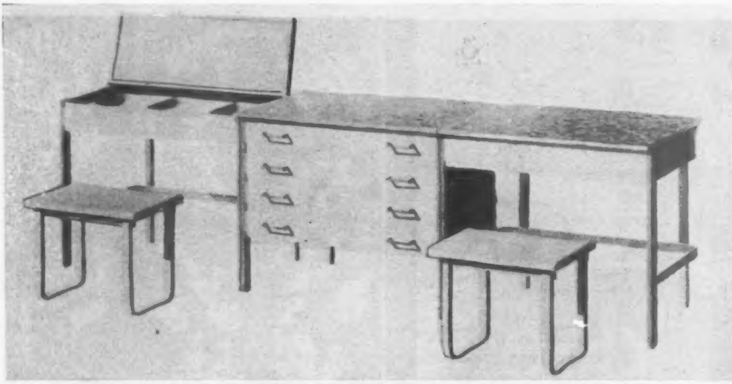


Left: *furniture for a bed-sitting room, by Martin Payne.* Right: *a dining-room chair for batch production, by Terence Poole*

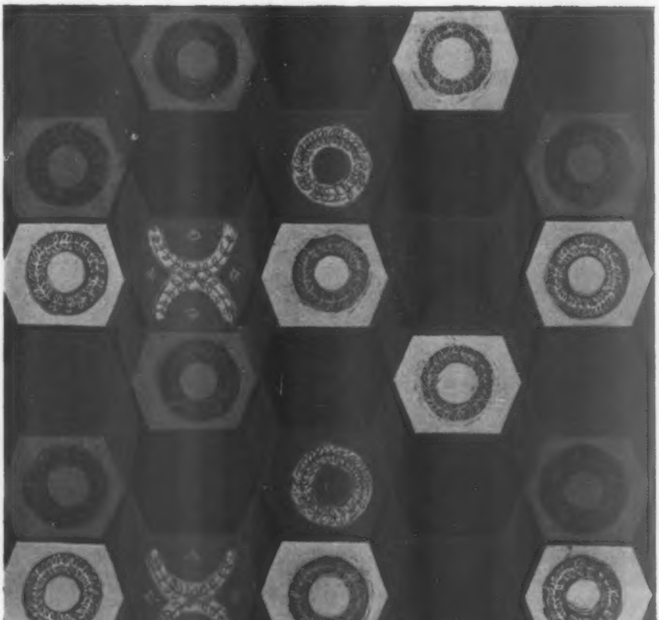


Left: *settings for a television variety programme:* above, *by Terence Andrews*. below, *by Lionel Radford*

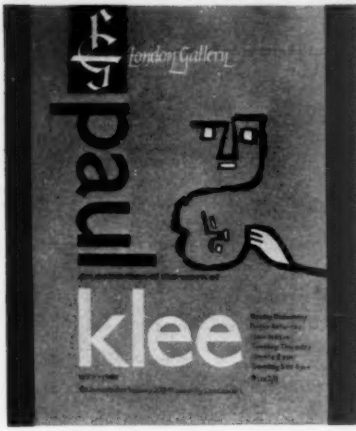
Right: *costume for 'The Emperor's New Clothes', by David Lovett*



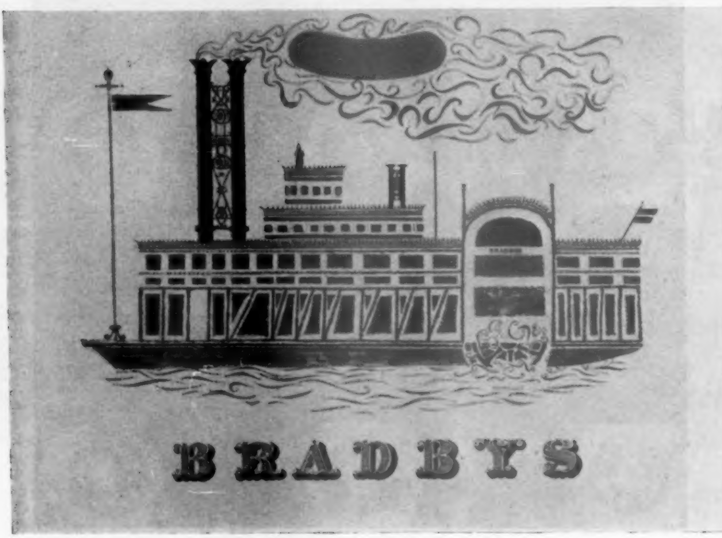
Perspective drawing for furniture for a bed-sitting room, by John Willis



Five-colour carpet suitable for hotels and public houses, by Roy Varndell

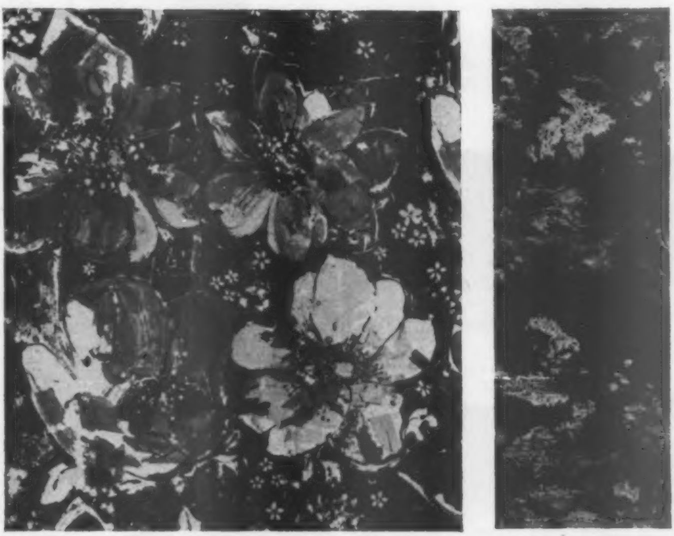


Left: *exhibition catalogue cover, by Charles Healey.* Right: *furnishing fabric for the drawing-room of a small British Embassy residence, by Howard Carter*



A carrier bag for a large modern West End store, by John Drysdale

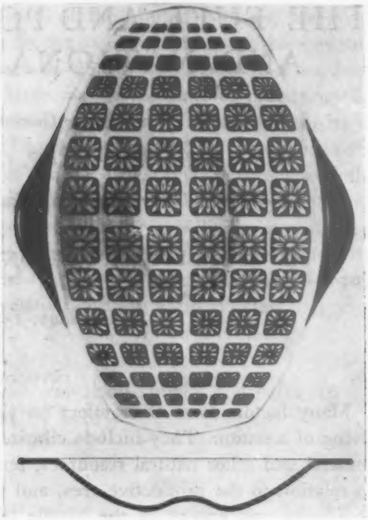
Left to right: *a soft travelling hat in feathers, a hat for formal dinner and evening wear in white velvet with plumes of gold tipped feathers, and an evening hat in black velvet with a plume of coq feathers, by James Wedge*



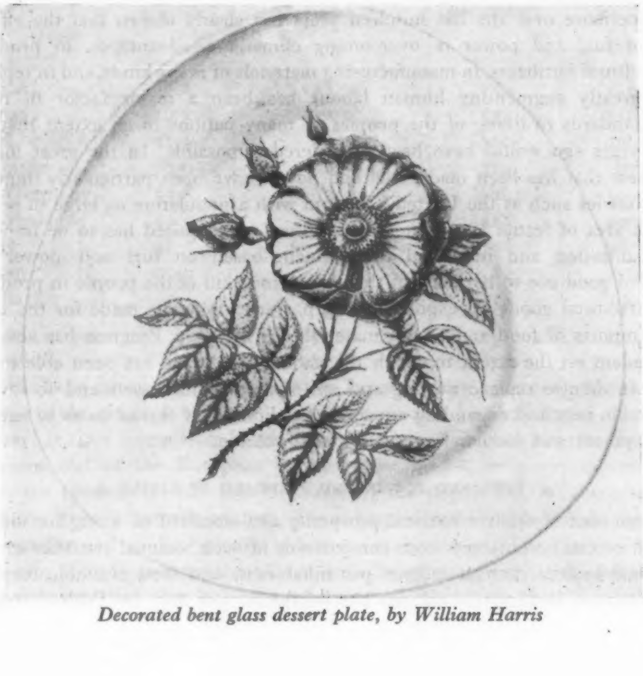
Left: *a silk, machine-printed fabric intended for evening wear, by Beatrice Tomlinson, who received the* SIR FRANK WARNER MEMORIAL MEDAL. Right: *a three-colour silk printed dress fabric, by Rosalie Taylor*

Left: *an electric fan heater, by John Patterson.*
Right: *a 'Perspex' shower bath, by Brian Coysten*

Left: *a pendant lighting fitting for the dining-room of an eighteenth-century house, by George Murray.* **Right:** *a free-standing open convector fire, by David Lewis*



Left: *decorated tea service, by Lesley Mackinnon.*
Right: *decorated bent glass dessert dish, by George Elliott*



Decorated bent glass dessert plate, by William Harris

THE FUEL AND POWER INDUSTRIES AND NATIONAL PROSPERITY

Three Cantor Lectures by

ALBERT PARKER, C.B.E., D.Sc., F.R.I.C.,

lately Director of Fuel Research, D.S.I.R.

I. WORLD AND NATIONAL ENERGY RESOURCES

Monday, 15th February

INTRODUCTION

Many factors have their effect on the material prosperity and standard of living of a nation. They include climate, the nature, extent and accessibility of mineral and other natural resources, fertility of the soil, size of the population in relation to the productive area, and the inventive genius, organizing ability, enterprise and energy of the people in making the best use of internal and external resources to develop agricuture and industry towards high overall productivity.

Experience over the last hundred years has clearly shown that the effective use of fuel and power in overcoming climatic disadvantages, in producing agricultural fertilizers, in manufacturing materials of many kinds, and in replacing and greatly augmenting human labour has been a major factor in raising the standards of living of the peoples of many nations to an extent that even fifty years ago would have been considered impossible. In the great material progress that has been made, fuel and power have been particularly important in countries such as the United Kingdom with a population so large in relation to the area of fertile land that much of the food required has to be imported. Mechanization and industrial development based on fuel and power have enabled good use to be made of the ability and skill of the people in producing manufactured goods for export, so that payment could be made for the necessary imports of food and of raw materials for industry. Progress has also been dependent on the extent to which the nation as a whole has been able to save from income to replace wasting and out-of-date capital assets and to invest in profitable new and expanding enterprises at home and abroad so as to maintain employment and further increase national income.

FUEL AND POWER AND STANDARD OF LIVING

Some idea of relative national prosperity and standard of living for different countries can be obtained from comparisons of such national statistics as those for total income, annual income per inhabitant, and food available for home consumption in terms of calories per inhabitant per day. In Table I statistics

of this kind, derived from the publications of the United Nations, are given for a few selected countries; they refer to the year 1956 because the statistics for energy consumption, to which reference will later be made, had not been issued by the United Nations for any later year at the time of preparing this lecture. In this table the selected countries are placed in descending order of average annual income per inhabitant. The figures for income are given in the equivalent of £ sterling calculated from income in national currency and the prevailing rate of exchange. Commercial prestige, balance of payments and political factors affect rates of exchange; and the cost of living at a definite standard varies with the country or even part of a country. In consequence, the data for income per inhabitant are not strictly proportionate to standard of living, but they are near enough to show the relative position approximately.

TABLE I

POPULATION, NATIONAL INCOME, AND NET FOOD SUPPLY FOR SELECTED COUNTRIES IN 1956

Country	*Population (millions)*	*National income equivalent in £1,000 million per annum*	*Income per capita equivalent in £ per annum*	*Net food per capita calories per day*
U.S.A. ...	168·2	122·70	730	3100
Canada ...	16·1	8·57	532	3100
U.K. ...	51·4	16·47	320	3200
Belgium ...	8·9	2·84	319	2900
W. Germany	50·8	12·50	226	3000
Netherlands	10·9	2·38	218	2900
Italy ...	48·3	6·57	136	2600
Japan ...	90·0	7·38	82	2100
India ...	387·3	7·05	18	1900

It has been estimated that to maintain human health and energy the national average of the net food required is equivalent to about 3,000 calories per person per day. It thus seems from Table I that the populations of the two American countries and of the European countries mentioned, with the exception of Italy, are reasonably well fed. On average, the populations of Japan and of India are grossly undernourished. The average income in Japan is only about one-quarter and in India only about one-eighteenth of that in the United Kingdom. The figures for the U.S.A. and Canada suggest that the inhabitants of those countries, after buying necessary food, should be able to provide for

greater personal comfort and more luxuries than those living in Europe, and should be able to save more from income if they allocate and spend their incomes wisely.

In Table II, the same countries as in Table I are placed in the same order and data are given for area, population density, and the annual consumption of fuel and power per inhabitant in the equivalent of tons of coal per annum. The figures for income per capita are also reproduced from Table I for ease of comparison with those for consumption of fuel and power. It should be mentioned

TABLE II

AREA, POPULATION DENSITY, FUEL AND POWER CONSUMPTION AND INCOME PER CAPITA FOR SELECTED COUNTRIES IN 1956

Country	*Area thousand sq. miles*	*Population density per sq. mile*	*Income per capita equivalent in £ per annum*	*Fuel and power consumption coal equivalent per capita tons per annum*
U.S.A. ...	3012·4	56	730	8·6
Canada ...	3845·8	4	532	8·3
U.K. ...	94·2	545	320	5·0
Belgium ...	11·8	750	319	4·3
W. Germany	95·7	531	226	3·6
Netherlands	12·5	870	218	2·5
Italy ...	116·3	415	136	1·1
Japan ...	142·8	630	82	1·1
India ...	1267·0	306	18	0·1

that the figures for consumption of fuel and power refer only to commercial sources of energy; they do not include such fuels as wood, peat, and dried dung that have been obtained locally by consumers and not bought on the market. If these 'non-commercial' fuels could be included, the figure in the last column of Table II would be increased for several of the countries, but probably by not more than the equivalent of 0·2 or 0·3 tons of coal per annum.

It will be observed from Table II that for the countries selected, with a decrease in the consumption of fuel and power per inhabitant there is a decrease in the average income per inhabitant, illustrating the importance of fuel and power as a factor in national prosperity.

The coal equivalent per inhabitant of the fuel and energy used for cooking, lighting, and for heating or cooling homes and other buildings to provide a

comfortable temperature are dependent on the climate, the efficiency of use of the fuels, and the average standard of comfort attained. In the American and European countries mentioned in Table II, the coal equivalents of the energy so used in 1956 were in the region of 2 tons in the U.S.A. and Canada, 1·3 tons in the United Kingdom, and between 0·5 and 0·85 ton in the other European countries. Deducting these amounts from the figures in the last column of Table II and allowing for the use of non-commercial fuels, it seems that the coal equivalents of the fuel and power used for industrial and commercial needs were about 6·5 tons in the U.S.A., 6 tons in Canada, 3·7 tons in the United Kingdom, 3·4 tons in Belgium, 3 tons in West Germany, 1·8 tons in the Netherlands, and less than 1 ton in Italy. Allowing for the fuel used for comfort heating in factories, it has been estimated that the power available to assist each industrial worker in the U.S.A. is about twice as great as in the United Kingdom. It is not surprising, therefore, that industrial production and national income in the U.S.A. are much greater per individual than in the United Kingdom.

Since national productivity and prosperity are so dependent on the availability of fuel and power to assist or replace manual labour, it is important in assessing future needs and prospects to survey the energy resources and to estimate probable changes in demand in this country and in other parts of the world.

ENERGY RESOURCES IN FOSSIL FUELS

During the last fifty years, the energy used by the world has been derived mainly from the fossil fuels, that is from those capital resources saved from energy income over long periods of thousands or millions of years. With the energy equivalent of the heat of combustion of one million tons of bituminous coal as the principal basic unit, it is of interest, therefore, to consider first those capital resources, so far as they have been estimated. They include coals (anthracite, bituminous coals, brown coals and lignites), petroleum, natural gas, oil shale, and peat.

Coals and Lignites

According to the available information, the probable world reserves of bituminous coals and anthracites are about 4 million million tons, and the probable reserves of brown coals and lignites are about 1 million million tons. This gives a total for all coals and lignites of 5 million million tons, equivalent in thermal value to about 4½ million million tons of bituminous coal, of which 1 million million tons have been proved. In Table III figures are given for the estimated resources in those countries mentioned in Tables I and II, and in a few other countries with considerable resources.

From the figures in Table III, it seems that one-third of the estimated world reserves of coals and lignites are in the U.S.A., one-quarter in the U.S.S.R., and nearly one-quarter in China, leaving only about one-fifth for the rest of the world, which has nearly two-thirds of the world population of 2,900 millions.

TABLE III

RESOURCES OF COALS, BROWN COALS AND LIGNITES FOR SELECTED COUNTRIES

Country	RESOURCES, THOUSANDS OF MILLION TONS			
	Bituminous coals and anthracites		*Brown coals and lignites*	
	Probable total	*Proved*	*Probable total*	*Proved*
U.S.A.	1303	431	420	—
U.S.S.R.	998	296	202	13
China	1011	—	1	—
West Germany ...	224	67	—	62
United Kingdom ...	171	128	—	—
Poland	80	15	18	—
Canada	63	42	24	12
South Africa ...	68	37	—	—
India	62	4	—	0·5
Australia	17	6	41	7
Japan	10	5	0·3	0·1
Belgium	6	3	—	—
Netherlands ...	3	3	—	—
Italy	0·6	0·5	0·5	0·3
Total ...	4017	1038	707	95

In general, in estimating the reserves of coals and lignites given in Table III, only those seams have been included that are believed to contain at least 1 ft. thickness of coal or lignite at a depth below the surface of not more than 4,000 ft. for bituminous coals and anthracites and not more than 1,650 ft. for brown coals and lignites. In some areas only thicker and shallower seams have been considered. For example, in the U.S.A. the estimates for bituminous coals and anthracites are limited to seams of a thickness of not less than 28 in. at a depth of not more than about 2,000 ft. In addition to these limitations, many large areas of the world have not been systematically surveyed. It is probable, therefore, that the estimates so far made are conservative. At the same time, it should be emphasized that for various reasons it would not be economic to bring to the surface more than a part of the coals and lignites in reserve, probably not more than one-third.

Petroleum

On several occasions during the last fifty years, it has been predicted that at the expected rates of production the oil resources of the world would be exhausted within 15 or 20 years. These predictions have all been proved incorrect, for though the rate of production has increased more rapidly than was expected, new reserves have been discovered and the estimates of remaining resources have been steadily increased. Twenty years ago, the proved reserves of petroleum for the world were estimated to be about 5,500 million tons. Since that time, the world has used about 11,000 million tons, yet production still continues at an increasing rate. A year ago, the estimate of the proved reserves was about 37,000 million, or about forty times the present annual rate of consumption of petroleum oil. Those reserves are distributed in the different main areas of the world as shown by the figures in Table IV.

TABLE IV

PROVED RESERVES OF PETROLEUM IN JANUARY, 1959

Country or Area	RESERVES	
	Millions of tons	*Per cent of total*
Asia—Middle East	23,250	62·3
Asia—Far East	1,280	3·4
U.S.A.	4,770	12·8
Canada	485	1·3
Mexico	345	0·9
Caribbean	2,480	6·6
Argentina	140	0·4
West Europe	200	0·5
East Europe	200	0·5
Africa	540	1·5
U.S.S.R.	3,525	9·5
Other countries	125	0·3
World total	37,340	100·0

Of the estimated proved reserves of about 37,300 million tons, 62 per cent are in the Middle East, 13 per cent in the U.S.A., 7 per cent in South and Central America, and 10 per cent in the U.S.S.R., leaving only about 8 per cent for the rest of the world.

It is certain that the further intensive explorations that are being made will lead to the discovery of other reserves of petroleum oil. Consideration of promising geological formations suggests the possibility of discovering additional oil reserves in the region of 70,000 million tons, or about twice the present estimate of proved reserves, making an overall total of possible and proved reserves of about 100,000 million tons. This quantity is equivalent in thermal value to about 150,000 million tons of bituminous coal.

Natural Gas

Combustible hydrocarbon gases, mostly methane, are always associated to a greater or less extent with underground reserves of oil and coal. From experience it seems reasonable to assume that the reserves of natural gas will be equivalent in thermal value to about 60 per cent of the reserves of oil and about 1 per cent of the reserves of coal. On these assumptions, the possible reserves of natural gas will be equivalent in thermal value to about 130,000 million tons of bituminous coal.

Oil Shale

In several parts of the world there are large deposits of oil shales and similar materials, which on heating or extraction yield oil. Estimates of the quantity of oil that might be recovered from world resources of oil shale have ranged from 20,000 million to 40,000 million tons. Of these estimated reserves, more than one-half are in the U.S.A. and nearly one-third in the U.S.S.R. In Alberta there are extensive deposits of bituminous tar sands, and small deposits in Utah and in Germany. Estimates of the quantity of crude oil that might be obtained from tar sands have ranged from as low as 100 million to as high as 40,000 million tons. In general, it has not so far been economic, in competition with petroleum, to recover oil from shales and tar sands.

Peat

There are large deposits of peat in many parts of the world. As found, peat contains 90 to 95 per cent of water, which is generally too costly to remove as a commercial proposition. The probable reserves are equivalent to at least 65,000 million tons of coal.

Total Resources of Fossil Fuels

In Table V, figures are given from available estimates to show the probable and possible energy resources of the world in the form of fossil fuels. The estimated reserves of all these fuels together are equivalent to nearly 5 million million tons of bituminous coal. Of this quantity 92 per cent occurs as coals and lignites and 6 per cent as petroleum, natural gas, and methane in coal measures. It is of interest to note that the reserves of fossil fuels, almost entirely coal, in the United Kingdom are equal to only about 3½ per cent of world reserves.

TABLE V

WORLD RESOURCES OF FOSSIL FUELS

Resource	BITUMINOUS COAL EQUIVALENT	
	Thousands of million tons	*Per cent of total*
Coals and lignites	4400	91·8
Petroleum	150	3·1
Natural gas and methane in coal measures	135	2·8
Oil in oil shale	45	0·9
Peat	65	1·4
Total	4795	100·0

ATOMIC ENERGY

Uranium is the source of energy from nuclear fission being used and developed at the present time. Thorium could similarly be used. From estimates so far made of the world resources of ores sufficiently rich in uranium and thorium to be economically worked, it seems that their energy value is much greater than that of the estimated reserves of coals and lignites, probably at least 25 times as great. There is also the possibility of the development of almost unlimited amounts of energy from nuclear fusion.

GEOTHERMAL ENERGY

There is an enormous reservoir of energy in the form of heat remaining within the earth from the energy with which the earth was originally endowed, and possibly from radioactive and other changes occurring in the earth with the release of heat; but only a very small part of this heat is within a few miles of the surface. It is used in a few places, for example in Iceland, Italy and New Zealand, where it emerges or can be released at the surface in the form of hot springs or vapour.

ENERGY INCOME FROM THE SUN

The primary source of energy available to the earth is the sun, which is radiating energy at the colossal rate equivalent to the heat generated by burning more than 10,000 million million tons of coal every second. Even at this rate, it is estimated that the sun's stock of energy would last for at least 10 million million years. Of this energy only a minute fraction reaches the earth and its atmosphere; and of the quantity received a large proportion is radiated or

reflected back into space. Even so, the energy received by the earth from the sun is equal to the heat of combustion of 17 million million tons of coal a year, or more than 4,000 times the heat of combustion of the solid, liquid and gaseous fuels used annually in the world at the present time. This enormous income of energy received from the sun is used by Nature to provide vegetable and animal life, and movements of air and water.

Wood

One quarter of the land area of the world is covered by forests. Such an area, if it could be fully developed, might provide a quantity of wood equivalent in fuel value to about 2,000 million tons of coal a year. Allowing for timber required for constructional purposes, however, it is unlikely that it would be practicable to provide wood as fuel equivalent to more than 500 million tons of coal a year.

Water Power

It has been estimated that from the world potential of non-tidal water power it might be possible each year to generate 6 million million units of electricity. It is unlikely, however, that it would be economic in the foreseeable future to develop non-tidal hydro-electric schemes to generate annually more than 800,000 million to one million million units. To generate this amount of electricity at thermal power stations using coal with present-day efficiency would require the annual consumption of 400 million to 500 million tons of coal.

If the power corresponding to the energy of the tides could be harnessed economically, it might be possible to generate 4 million million units of electricity a year. Several tidal schemes for estuaries where the tidal range is unusually high, including the Severn barrage in this country, have been considered, but because of the high capital cost, only one has reached the stage of construction; that is the scheme for the Rance estuary near St. Malo in France to generate about 800 million units a year, equivalent to an annual saving of 0·4 million tons of coal.

Wind Power

World resources of wind power are no doubt greater than those of water power, but owing to the great variations in the velocity of the wind at most places it is unlikely that it will be economic in the near future to use the energy of wind to generate substantial quantities of electricity or mechanical power. There may be an extension of the harnessing of the wind for relatively small power installations.

TOTAL ENERGY RESOURCES

It is clear from the estimates already considered that the amounts of potential and sensible energy within the earth and being received from the sun are colossal. The problem facing the world is not due to a shortage of total energy resources but is that of harnessing the resources at reasonable cost to meet the various and rapidly growing needs of an increasing population.

At the present time the world relies mainly for heat and power on the use of the fossil fuels, coals and lignites, petroleum, and natural gas. These fuels are being

used up faster than nature produces them; and they are not always conveniently distributed in the accessible crust of the earth. The questions that arise, therefore, are for how long will the economically recoverable reserves of fossil fuels meet world needs, and will economic methods of harnessing the other resources of energy be developed before the fossil fuels are exhausted or become far too costly. To assist in answering these questions, it is necessary to consider what are and what will be world demands for fuel and power.

WORLD DEMANDS FOR FUEL AND POWER

Figures for world consumption of the principal forms of fuel and energy during the year 1958, when world population was about 2,850 millions, are given in Table VI. In this table the amounts of fuel and energy are expressed in their equivalents of millions of tons of bituminous coal. For example, the amount of petroleum produced in that year was about 925 million tons, equivalent to 1,350 million tons of coal; the electricity generated from water power would have required the consumption of 250 million tons of coal if generated at thermal power stations.

According to Table VI, world consumption of fuel and energy in 1958 was equivalent to 4,550 million tons of coal, or an average of 1·6 tons for each individual of the population. Less than one-half, 46 per cent, was provided by coals and lignites, and 41 per cent by petroleum and natural gas.

TABLE VI

WORLD CONSUMPTION OF FUEL AND ENERGY IN 1958 EXPRESSED IN BITUMINOUS COAL EQUIVALENT

Fuel or energy	*Coal equivalent million tons*	*Per cent of total*
Coals and lignites	2100	46·1
Petroleum	1350	29·7
Natural gas	500	11·0
Water power	250	5·5
Wood, peat, shale oil, etc. ...	350	7·7
Total	4550	100·0

It is interesting to compare the position in 1958 with that 20 years earlier in 1938. In 1958 world population was 30 per cent more and world consumption of fuel and energy was 90 per cent more than in 1938. Over this period, the quantity of coals and lignites used annually rose by 60 per cent, consumption of petroleum trebled, and the consumption of natural gas quadrupled. At the same time, the efficiency of utilization of the fuels was increased.

It is also of interest to observe that in 1958 the U.S.A. consumed about one-third of the fuel and energy used in the world, including one-sixth of the coals, one-half of the petroleum, and four-fifths of the natural gas, though the population of the U.S.A. is only one-sixteenth of that of the world. Over the years 1938 to 1958, the annual production in the U.S.S.R. of bituminous coal has been increased from 113 million to 353 million tons, brown coal and lignite from 18 million to 143 million tons, petroleum from 28 million to 112 million tons, natural gas from 83,000 million cubic feet to 1 million million cubic feet, and hydro-electricity from 6,000 million to 46,000 million kilowatt hours.

FUTURE WORLD ENERGY DEMAND

If world population and energy demand continued to increase at the same average geometric rate as during the last twenty years, then by the year 2000, or only 40 years from now, the population would reach about 5,000 millions and the annual energy demand would be equivalent to 17,500 million tons of coal; by the year 2100 the population would reach 18,500 millions and the annual energy demand would be equivalent to 435,000 million tons of coal. In comparison with the population of 5,000 millions in the year 2000 as estimated by this method, a report on *The Future Growth of Population* issued by the United Nations in 1958 gave an estimate of more than 6,000 millions. Clearly, the unprecedented rate of growth of the population that has occurred since the beginning of the twentieth century cannot continue. Two-thirds of the population are to-day under-nourished, and it seems unlikely that in the foreseeable future sufficient food could be produced for a population greater than about 5,000 millions. If Man is incapable of controlling population growth intelligently, then hard Nature will exercise the control.

It follows, therefore, that it cannot be assumed that the rate of increase in world energy demand that has occurred during the last few decades will continue for more than another few decades. There will be a substantial increase, but the known reserves of fossil fuels, hydro-electric potential, and nuclear fuels will ensure an adequate supply for the world as a whole, until further reserves are discovered and new and economic methods of generating energy and harnessing energy income have been discovered and developed. There will be occasional and particularly local shortages, but necessity is the mother of invention.

ENERGY DEMAND IN THE UNITED KINGDOM

In Table VII, figures are given in millions of tons of coal equivalent for the consumption of coal, oil, and hydro-electricity within the United Kingdom for selected years during the period from 1938 to 1958. Over this period total energy consumption rose by the equivalent of 59 million tons of coal a year, or by 31 per cent of the consumption in 1938. The quantity of coal used increased by only 23 million tons or 13 per cent, whereas the coal equivalent of the petroleum oil used rose by 35 million tons and was more than $3\frac{1}{2}$ times as great in 1958 as in 1938. The population of the United Kingdom was about 47·5 millions in 1938 and 51·7 millions in 1958, so that the annual fuel and energy

TABLE VII

ANNUAL PRIMARY FUEL AND ENERGY CONSUMPTION WITHIN THE UNITED KINGDOM DURING THE PERIOD 1938 TO 1958

(*Million Tons of Coal Equivalent*)

Year	*Coal*	*Oil*	*Hydro-electricity*	*Total*
1938	175·5	13·0	0·7	189·2
1946	185·6	14·3	0·8	200·7
1950	201·0	22·7	0·9	224·6
1952	204·8	26·1	1·0	231·9
1954	213·1	31·4	1·3	245·8
1956	214·6	38·0	1·3	253·9
1958	198·9	47·6	1·4	248·1*

* Includes electricity from nuclear power equivalent to 0·15 million tons of coal.

consumption per person was equivalent to 4·0 tons of coal in 1938 and 4·8 tons in 1958. It has been estimated that the population will be nearly 56 millions in 1980 and about 58 millions in the year 2000. Assuming a continuation of increase in energy demand at about the same rate as during the period 1938 to 1958, the demand would be equivalent to about 280 million tons of coal in 1970, 310 millions in 1980, and 370 million tons in the year 2000.

The questions that at once arise are in what proportions these prospective demands will be met by coal, petroleum oils, nuclear energy, and other forms of energy, and to what extent and by what methods the coal will be converted or used to provide coke, gas, electricity and oil. These questions will be considered later. Important factors will be the relative prices, the overall costs of the useful energy obtained, and the effects of the different fuels and forms of energy on industrial productivity.

Meanwhile, it should be mentioned that there is sufficient workable coal in the United Kingdom to provide 250 million tons a year for 200 years. There is enormous scope for scientific effort in research, inventive genius and the development of new methods of using fuels to improve thermal, and particularly economic, efficiency. The subject is of great importance. At the present time, the amount spent on fuel and power by industrial and domestic consumers in this country is in the region of £2,000 million a year (excluding about £350 million in taxes on hydro-carbon oils), or more than 10 per cent of the national income.

II. PRODUCTION AND TREATMENT OF COALS AND OILS

Monday, 22nd February

COAL

There is evidence to show that coal has been used as a source of heat for many centuries, though not in any important amount until 150 or 200 years ago. It was during the latter part of the eighteenth century that there were signs of the beginning of the enormous developments in the use of coal that occurred during the nineteenth century, particularly in the second half of that period. Great Britain was fortunate in possessing large reserves of coal of good quality, and of all types except brown coal and lignite. Early realization of the possibilities in the use of coal for the production of heat, power and light, and the skill and enterprise of our scientists, engineers and industrialists of 150 years ago gave Great Britain a good lead in the industrial developments that followed. In consequence, this country soon occupied a leading position in world industry. This industrialization later spread rapidly to some other countries with good reserves of coal, especially in Europe and America.

In Great Britain, the rapid rise in the use of coal was accompanied by a marked rise in the population that could be supported. In 1700 the population was only about 6 millions and the output of coal was no more than about 3 million tons, equivalent to only 10 cwt. per annum for each person. A century later, in 1800, the population was about 11 millions and the output of coal was in the region of 12 million tons, or roughly one ton for each member of the population. Then began the great acceleration in the size of the population and in the production of coal, until by the year 1900 Great Britain had a population of 37 millions and an annual coal production in the region of 220 million tons, or 6 tons of coal for each inhabitant. By that time, coal not only met all the needs of the country for heat and power, but there had for many years been a considerable surplus for export to assist in paying for imports of food and of raw materials for industry. The annual production of coal continued to increase until in 1913 it reached the record figure of 287 million tons, of which 73 million tons was exported and 21 million tons was used by vessels engaged in foreign trade or operating outside territorial waters; the population had increased to about 42 millions, so that the coal production was equivalent to nearly 7 tons per person per annum and the inland consumption was equivalent to 4·6 tons per person per annum. There was little competition from petroleum oils with only about one million tons used as fuel in Great Britain.

Since 1913, when coal provided 99 per cent of the fuel and energy requirements of Great Britain and Northern Ireland, and 94 million tons was sold for export and for ships engaged in foreign trade, the part played by coal in the national economy has changed considerably; though even in 1958 coal provided 80 per cent of the fuel and energy requirements of the country. The change has been caused by many factors, including changes in the relative prices of primary and

TABLE VIII

ANNUAL PRODUCTION, INLAND USE, AND EXPORT OF COAL, AND COAL EQUIVALENT OF TOTAL INLAND FUEL CONSUMPTION IN THE UNITED KINGDOM, FROM 1913 TO 1958

Period or Year	MILLIONS OF TONS PER ANNUM			
	Coal production	*Coal inland use*	*Coal exports and ships' bunkers net*	*All Fuels coal equivalent*
1913–22	241	183	58	186
1923–32	233	167	66	173
1933–42	221	180	41	192
1943–52	205*	193	12	212
1954	224*	213	14	246
1956	222*	215	7	254
1958	216*	199	8	248

* Including annual amounts of opencast coal in millions of tons of 10 for 1943–1952, 10 for 1954, 12 for 1956, and 14 for 1958.

secondary fuels, developments in the use of petroleum oils, more efficient use of fuels and power, and world competition operating mostly in the direction of lowering the demand for coal, with greater demands for heat, power and the products from coal operating in the opposite direction. In Table VIII, figures are given to indicate the extent of the change over the last 40 to 50 years. During this period the quantity of coal exported or used in ships' bunkers on foreign trade fell from about 60 million tons to only 7 or 8 million tons a year. The coal equivalent of the hydro-electricity generated rose to about 1·5 million tons a year and that of the petroleum oils used as fuels increased from about 3 million to 48 million tons a year.

Before 1936 the value of exports of fuels exceeded that of imports, and from 1936 to 1939 the value of imports exceeded that of exports by an average of only about £1·4 million a year. In each year since 1939 the value of fuel imports has been greater than the value of exports by amounts ranging from £45 million in 1940 to £310 million in 1957 and £302 million in 1958. The change over from a credit to a debit in the balance of trade in fuels, however, should not be considered in isolation. If the fuels are used efficiently, they assist in increasing the production of manufactured goods for inland use and for export. The real test is the overall balance of all transactions with the rest of the world; on that basis, the position during the last few years has not been unsatisfactory.

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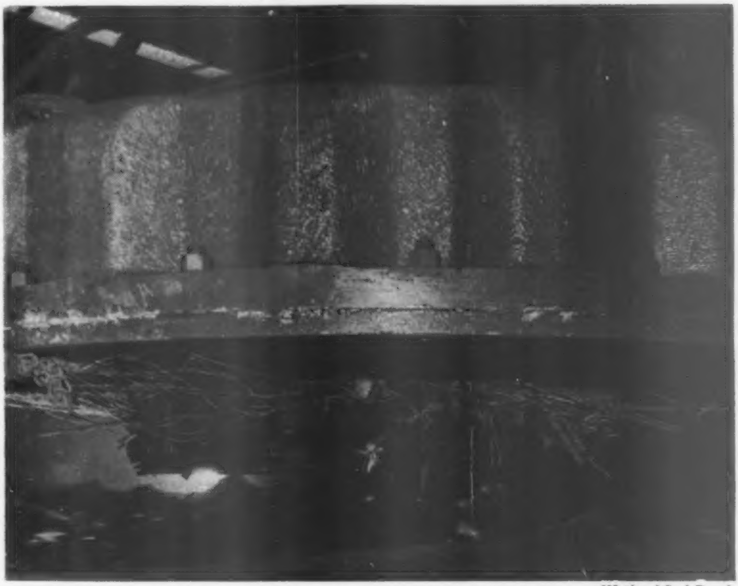
FIGURE 1. *Cutting coal by hand*

Mechanization of Coal Production

In the development of coal-mining it is natural that the most easily accessible and thickest seams of coals of good quality have been worked first to keep down costs. As these easily accessible seams are gradually exhausted, the difficulties of mining steadily increase. During the nineteenth century there was little or no mechanization in the industry and the winning of coal was dependent almost entirely on hard manual labour. Even to-day, there are many pits where the coal is cut by hand as shown in Figure 1. The men shown in that picture were working under comparatively good conditions, for the seam is 6 to 7 ft. in thickness, whereas many seams of coal in this country are only about 2 ft. in thickness.

['Coal' magazine

FIGURE 2. *Cutting coal by machine*



[National Coal Board

FIGURE 3. *Magnetic machine removing metal from coal*

During the last forty years there has been a steady increase in the mechanization of the operations of cutting, loading, conveying, and cleaning the coals. If there had not been this progress in mechanization the output of coal per man employed would have fallen considerably. In 1920 only 12 per cent of the coal mined was mechanically cut; to-day the proportion is 90 per cent. The progress in mechanization since 1937 is shown by the figures in Table IX.

TABLE IX

PERCENTAGE OF DEEP-MINED COAL MECHANICALLY CUT, LOADED, CONVEYED, AND CLEANED, AND OUTPUT PER MAN PER YEAR FOR ALL EMPLOYEES

Year	*Cut per cent*	*Loaded per cent*	*Conveyed per cent*	*Cleaned per cent*	*Output per man year tons*
1937–38	58	—	53	45	302
1945	72	1	71	47	249
1950	79	4	85	52	295
1952	82	5	88	53	301
1954	84	7	90	55	303
1956	87	14	92	59	298
1958	89	26	94	64	288

Figure 2 shows one type of machine in operation for cutting the coal underground and loading it on to the conveyor. Figure 3 shows a magnetic device for the removal of metal and other magnetic material from the coal as it proceeds to coal-cleaning plant above ground; and Figure 4 is a view of a plant in which small coal is cleaned by a system of froth flotation.

It is somewhat disappointing that the overall considerable increase in mechanization has not so far brought about a marked increase in the average output of coal per man employed for the industry as a whole, while mechanization of coal cutting has greatly increased the proportion of the coal obtained in small sizes. It should be pointed out, however, that owing to great differences in natural conditions, the output per man employed varies considerably from one coalfield to another. The average output per man is twice as great in the East Midlands as in Scotland and South Wales, and the variation from pit to pit is even greater. A few years ago, when there was an acute shortage of coal, it was not practicable to close down the less productive pits and extend mining in the more productive coalfields. The position has now changed, but it takes time to sink new shafts and extend mining in any area. With the closing of some pits and extension of mining in certain areas, the overall average output per man employed should improve appreciably over the next ten years.

['Colliery Engineering'

FIGURE 4. *Froth-flotation cells for cleaning small coal*

Cost of Coal Production

If British coal is to hold its place in the future in the home and overseas markets in competition with foreign coal, with the more convenient oils, with gas made from oil and imported natural gas, and with electricity made at oil-fired and at nuclear power stations, it is essential that the price to the consumer should not be too high.

In Table X, figures are given to show the overall average costs of producing coal at the pithead, the proportion attributed to wages of employees, and the average weekly wages (including the value of allowances in kind) of employees during selected years from 1937 to 1958. These figures show that from 1950 to 1958 the average cost of production of coal per ton rose by 85 per cent. For comparison it is interesting to note that over the same period the average price of gas increased by 62 per cent, electricity by 32 per cent, and petroleum fuel oils by 31 per cent. In comparison with the value of the products sold, the cost of labour is greater in the coal industry than in the gas, electricity and oil industries. There are other factors, but taking them all into account it seems likely that if wage rates in general rise the price of coal will rise relatively more than the prices of gas, electricity and oil.

TABLE X

COSTS OF COAL PRODUCTION PER TON AND WEEKLY EARNINGS OF WAGE-EARNERS (ALL AGES) IN SELECTED YEARS FROM 1937 TO 1958

Year	*Wages costs per ton* s. d.	*Total costs per ton* s. d.	*Average weekly earnings of wage-earners* s. d.
1937–8	10 2	15 4	57 8
1945	25 5	36 7	116 11
1950	29 5	45 5	182 4
1952	35 9	56 9	225 0
1954	38 4	61 11	245 11
1956	44 9	74 5	284 8
1958	48 9	83 11	300 3

Types of Coal

All the coals available in Great Britain are bituminous or anthracitic in type. There are no commercial reserves in this country of brown coals and lignites, which are of much lower calorific value than bituminous coals and anthracites, may contain 25 to 50 per cent of moisture and usually break down to small particles on storage or weathering.

There are several grades of anthracite and many types and qualities of bituminous coal. For certain purposes, for example in the manufacture of gas and coke by the processes usually employed, coals of particular types and qualities have to be selected. To assist in the selection of coals for specific purposes there are now in use in this country a system of size grading and a system of classification according to rank. The classification by rank was introduced by the Fuel Research Station of the Department of Scientific and Industrial Research during the 1939–45 war and has since been developed by the National Coal Board. Broadly, it is based on the amount of volatile matter (gas and tar) evolved when the coal is heated in the absence of air and on the character of the residue or coke so obtained. There are nine main groups designated by the numbers 100, 200 and so on to 900, and each main group is divided into sub-groups designated 101, 102, 201, 202, etc. The anthracites containing an amount of volatile matter not greater than 9 per cent are in group 100,. and the so-called steam coals with amounts of volatile matter in the range of 9 to 19·5 per cent are in group 200. Coals in group 300 contain 19·6 to 32 per cent of volatile matter, and those in groups 400 to 900 contain more than 32 per cent of volatile matter. Further subdivision is based on the coking characteristics of the coals.

The hardest cokes are made from the coals of ranks 301 and 401*a*, but the quantities available are only a small proportion (5 or 6 per cent) of the total quantity of coal produced in Great Britain. Fortunately, cokes suitable for blast furnaces can be made also from blends of these coals with coals of lower rank and even from coals of ranks 500 and 600 alone. Other desirable characteristics of coals for making coke for blast furnaces are that the ash content should not be more than 7 or 8 per cent and the sulphur content should not be more than about 1·7 per cent. In the production of certain types of steel it is important that the pig iron should have a low content of phosphorus. It is then necessary to select coals that will give blast furnace coke containing not more than about 0·01 per cent of phosphorus.

In selecting coals for the gas industry, the emphasis with the usual methods of gas manufacture is on the quantity and quality of the gas made and on the quality of the coke. It is not necessary that the coke should be so hard as that made by the coking industry for the iron and steel industry. The gas industry accordingly uses a fairly wide range of types of coal, mostly from groups 500 and 600, with a substantial quantity from group 700 and smaller quantities from groups 400, 802 and 902.

Other examples could be given of the need for selection of coals for specific purposes, but in making the selection the availability of the supplies of the coals of different types must be taken into account. In 1957 and 1958 more than one quarter of the home consumption of coal was used by the coke and gas industries. Fortunately, almost any kind of coal can be used with reasonable efficiency for raising steam, and in 1957 and 1958 the electricity supply industry alone used nearly one quarter of the home consumption for this purpose.

Main Uses of Coal in Great Britain

As it is necessary to select coals of particular types and qualities for some purposes, it is of interest to consider what are the main uses of coal in this country. In Table XI, figures are given to show the main uses during the period 1948 to 1958.

In addition to coal, the electricity stations used in 1958 nearly 2·6 million tons of oil and 1·0 million tons of coke and coke breeze compared with only 0·04 million tons of oil and 0·4 million tons of coke in 1948. The total coal equivalent of the fuel used by electricity works thus increased from about 30 million tons in 1948 to 51 million tons in 1958 or by 70 per cent. At the same time the efficiency of generation of electricity was improved so that the quantity of electricity sold was more than twice as great in 1958 as in 1948. Over the same period, the gas industry increased the sales of gas by about 18 per cent; this additional gas was obtained by some improvement in process efficiency, using somewhat more coke and oil, and purchasing more gas mainly from the coke oven industry. The quantity of coal used by the railways has declined with the extension in electrification and the use of more Diesel-driven locomotives; and the quantity of coal used direct by the coal-mining industry has decreased as a result of improved efficiency and the purchase of more electricity for power.

TABLE XI

INLAND USES OF COAL IN GREAT BRITAIN

(*Million Tons per Annum*)

Year	1948	1952	1956	1958
Electricity works	28·8	35·5	45·6	46·2
Gas works	24·6	27·7	27·8	24·8
Coke ovens	22·3	25·1	29·3	27·8
Railways	14·6	13·9	12·1	10·3
Collieries	11·3	10·3	8·0	6·5
Industry	38·3	38·6	39·4	33·6
Domestic	32·1	31·6	32·2	30·9
Miners' coal	5·0	5·2	5·3	5·1
Coastwise bunkers	0·9	0·8	0·6	0·4
Miscellaneous	13·4	15·0	15·1	14·3
Total	191·3	203·7	215·4	199·9

In addition to coal and coke, domestic consumers use considerable amounts of gas and electricity and between 1 and 2 million tons of oil a year. In 1948 the coal equivalent of the fuels and power used by domestic consumers was about 62 million tons and in 1958 it was about 68 million tons.

PETROLEUM

More than 100 years ago James Young in Scotland discovered that oil could be obtained from certain local shales by heating or distillation. This led to his development of the shale oil industry, which until recently has been in continuous operation in Scotland. Over the years 1922 to 1924 the annual production of oil from Scottish shale was more than 200,000 tons. Latterly, the annual production decreased, largely because of the gradual exhaustion of the local reserves sufficiently rich in oil to make the process economic in competition with petroleum; in 1958 the quantity of oil produced was only about 60,000 tons. Before Young's discovery the world relied almost entirely on vegetable and animal products for any liquid fuels or lubricants.

In 1859, Colonel Drake struck petroleum oil in Pennsylvania and then began the development of the petroleum oil industry in the U.S.A. For many years the main demand was for oil as an illuminant to replace colza oil; another demand was for lubricating oil. By 1860 oil was being produced in Roumania, Russia, Italy, and Canada. Production in the Far East had been begun by 1875, in South America by 1900, in the Caribbean by 1910, and in the Middle East between 1910 and 1915. Until sixty or seventy years ago, the key product was kerosine, which included as wide a range of distillate as could be burned in oil lamps.

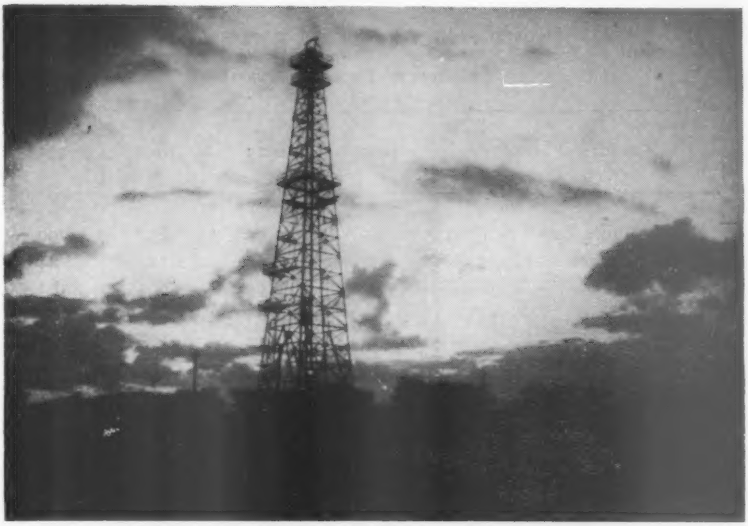


FIGURE 5. *Drilling rig in tests for oil and natural gas*

Other products of distillation were of relatively low value and much of the oil, including the lighter products now in demand for petrol engines, was wasted.

At one period, after the great improvement in gas lighting with the introduction in 1887 of the Welsbach incandescent mantle, the opinion was held in some quarters that the oil industry would decline. The prospect entirely changed, however, with the development of the internal combustion engine using oil, especially for road transport and later for aircraft. As a result, since the beginning of this century, the industry has expanded at an increasing rate. In 1880, world production of crude petroleum was only 4 million tons, of which 3·5 million tons was produced in the U S A. By 1890 world production was 10·4 million tons, including 6·2 million tons in the U.S.A. and 4 million tons in Russia and Eastern Europe. In 1959 world production was about 980 million tons. The increase in world demand and the increases in production in the main areas of supply during the period 1900 to 1958 are shown by the figures in Table XII. The annual production of oil is now about 50 times as great as it was 60 years ago and twice as great as eleven or twelve years ago. Until and including 1953, more than one half of the oil was produced in the U.S.A., and in that year 17·5 per cent came from the Middle East and 14·5 per cent from the Caribbean area. By 1959 the proportion produced in the U.S.A. had fallen to 35 per cent, while the proportions in the Middle East and the Caribbean area had risen to 24 per cent and 16 per cent, respectively. During the next ten years, unless there are

TABLE XII

WORLD PRODUCTION OF CRUDE PETROLEUM

(*Millions of Tons per Annum*)

Country or Area	1900	1925	1950	1958
Asia—Middle East	—	5	85	209
Asia—Far East	1	5	12	24
U.S.A.	8	103	288	360
Canada	—	1	4	22
Mexico	—	16	10	13
Caribbean	—	4	86	148
South America	—	2	6	12
Africa	—	—	2	4
U.S.S.R. and East Europe ...	11	10	43	124
W. Europe	—	—	4	12
Total	20	146	540	928

political complications, it is probable that an increasing proportion of world oil will be produced in the Middle East, which area contains 60 per cent of the proved reserves.

Exploration

With the increasing demand for oil, the industry is obliged to incur heavy expenditure in the search for new resources in many parts of the world. In the early days of the industry the prospector was guided in his selection of sites for 'wild cat' drillings by 'hunch' based on general surface geology. Exploration has now become a highly scientific business involving some or all of the following steps—general reconnaissance from the air, stereoscopic aerial photography and photogeological interpretation, detailed ground geological surveys, and geophysical surveys. The geophysical methods include the measurement of gravity by instruments capable of measuring changes of one part in 100 millions, the measurement of the earth's magnetic field at different points, and seismic observations of the travel of waves of sound through the earth's crust when charges of explosive are fired in shot holes at different points and depths. These methods of survey do no more than lead to an assessment of the probability of finding oil. The next step is to drill test wells, and large numbers may have to be drilled before any commercial reserve of oil is found. Figure 5 shows a drilling rig erected in this country in efforts to find oil or natural gas.

[*British Petroleum Co. Ltd.*

FIGURE 6. *A pump at an oil well*

Production of Crude Oil

The conditions of pressure and the composition of the oil underground differ considerably in the different oil fields. In some areas the natural or gas pressure is such that the oil flows to the surface of the well without any assistance. In other instances the oil has to be pumped, or forced to the surface by a pressure of gas applied artificially. Figure 6 shows a typical pump at an oil well. Special methods have sometimes to be adopted to separate the natural gas and the salt water that often accompany the crude oil.

Oil Refining

It is rarely that the crude oil as obtained is of the quality or composition to suit any of the modern needs. Ordinarily it has to be processed or refined to provide the market requirements of the various grades of motor and aviation spirit, aviation turbine fuels, white spirit and solvents, kerosine, gas oil, diesel

[British Petroleum Co. Ltd.

FIGURE 7. *A modern oil refinery*

oil, and fuel oils for furnaces. Modern oil refineries include highly developed chemical engineering processes of distillation, solvent extraction, thermal and catalytic cracking and reforming, polymerisation, alkylation, isomerisation, and different chemical treatments of the various fractions of the oil. Figure 7 shows part of a modern oil refinery in Kent.

The extent to which these refining processes are operated, and the conditions of operation, are varied to suit the particular crude oil and to provide the different products, so far as is practicable, in the proportions required by the markets to be served. The relative market demands, inland and export, for the products differ in different countries. For example, as shown in Table XIII, of the major refined products made in the U.S.A. in 1957, 48 per cent was motor and aviation spirit and 18 per cent was residual fuel oil, whereas from the refineries in the United Kingdom in that year 45 per cent was residual fuel oil and only 26 per cent was motor and aviation spirit.

The market requirements are not static either in quantity or quality of each of the refined products. For example, the high-compression engines of to-day require motor spirit of different composition and higher octane number than those of only a few years ago. Improvements have also been made in the quality of the fuels for diesel engines. To effect further improvements in the methods of refining and to be ever ready for the changing needs of the market, the oil industry

TABLE XIII

MAJOR PRODUCTS OF OIL REFINING IN THE U.S.A. AND IN THE UNITED KINGDOM IN 1957

Product	*U.S.A.*		*United Kingdom*	
	million tons	*per cent*	*million tons*	*per cent*
Motor and aviation spirit ...	163·3	48·3	6·0	25·7
Kerosine	14·0	4·1	0·9	3·8
Distillate fuel oils	90·6	26·8	5·1	21·8
Residual fuel oils	62·1	18·4	10·6	45·3
Lubricating oil	8·0	2·4	0·8	3·4
Total	338·0	100·0	23·4	100·0

spends annually very large and increasing amounts on research and development work.

III. NATURAL AND MANUFACTURED GAS

Monday, 29th February

NATURAL GAS

It has already been mentioned that petroleum, as found underground, is usually accompanied by natural gas. The quantity of natural gas in relation to the quantity of petroleum oil varies greatly from one oilfield to another. There are also many areas where there are large quantities of natural gas without any appreciable amount of liquid petroleum. In the early days of the petroleum oil industry, the natural gas discharged with the petroleum was largely wasted and burned in flares, much as surplus manufactured gas from coke ovens was burned and wasted in this country. There is still some waste of natural gas at oilfields in areas far removed from thickly-populated industrial centres—for example in the Middle East.

During the last few decades, there has been considerable development in many countries, particularly in America, Europe and the U.S.S.R., in the treatment and distribution of natural gas to meet industrial and domestic needs for heat and power; and natural gas is now a fuel of great importance in many areas. The gas consists mainly of methane with smaller proportions of ethane, propane, butane and other higher hydrocarbons. In most instances, the gas has to be conveyed under pressure through long mains or pipe lines to the areas of use; these mains may extend to hundreds of miles or even a thousand miles or more. In such circumstances, most of the higher hydrocarbons must be removed at the source before the gas enters the distribution mains, otherwise the higher hydrocarbons would be deposited as liquid in the mains and in the service pipes of the distributing system. These higher hydrocarbons are removed either by a system of washing the gas with oil or by cooling the gas to a low temperature or by a combination of the two methods; and they are recovered partly as light oil or gasoline and partly as low-pressure gas or bottled gas.

In many instances, the crude natural gas contains hydrogen sulphide and carbon dioxide in amounts that vary considerably with the source of the gas. The hydrogen sulphide must be removed before the gas is distributed for public supply; and if the proportion of carbon dioxide is high, it is desirable that it should be reduced. Removal of the hydrogen sulphide and carbon dioxide is effected by scrubbing the gas under pressure with an ethanolamine, usually monoethanolamine. By heating the ethanolamine after use in the gas scrubber, the hydrogen sulphide and carbon dioxide are released and the hydrogen sulphide is converted by partial combustion with air by the Claus process to give practically pure sulphur. A few years ago, there was a world shortage of sulphur, which is used mainly for the manufacture of sulphuric acid. To-day, largely owing to the additional supplies of sulphur obtained from the hydrogen sulphide removed in the purification of natural gas and in the treatment of petroleum refinery

gas, there are ample supplies of sulphur to meet world demand; and there are plans to extend the use of natural gas, including the recovery of sulphur from crude gas containing hydrogen sulphide.

One example of gas of this type with which the author has been concerned is a volume of about 80 million cubic feet per day of a mixture of petroleum well gases and refinery gases at Kirkuk in Iraq. This mixture, which has so far been wasted, contains on average about 44 per cent of methane, 44 per cent of higher hydrocarbons, 10 per cent of hydrogen sulphide, and 2 per cent of carbon dioxide. Under a scheme of treatment that has been planned, this gas could provide per day about 60 million cubic feet of gas for general distribution, 900 tons of bottled gas, and 300 tons of sulphur. Another example is the natural gas discovered in recent years near the village of Lacq in south-west France at a depth of about 12,000 feet below the surface and a pressure of nearly 1,000 lb. per square inch. According to the latest estimates, the amount of gas in the recoverable reserves of that area is at least 5 million million cubic feet. The gas contains about 70 per cent of methane, 5 per cent of higher hydrocarbons, 15 per cent of hydrogen sulphide, and 10 per cent of carbon dioxide. In 1958, the production of purified gas from the deposits at Lacq was 13,850 million cubic feet or about 150 million therms; and the quantities of the other products were 127,000 tons of sulphur, 21,000 tons of petrol, and 8,600 tons of propane and butane. The plant has since been greatly enlarged. When further extensions that have been planned are completed in 1961 the annual production should be about 150,000 million cubic feet of gas, of a calorific value of 1,100 B.t.u. per cubic foot, or 1,650 million therms, 1·3 million tons of sulphur, 250,000 tons of petrol, and 113,000 tons of propane and butane. It is interesting to note that the calorific value of the gas at 1,100 B.t.u. per cubic foot is somewhat more than twice that of the gas supply in this country, and that a production of 1,650 million therms per annum is about three-fifths of the whole of the gas sold by the British gas industry.

There is no doubt that the discovery of the large reserves of natural gas near Lacq will have a marked effect on the fuel and power situation in France. Recently, reserves of oil and natural gas have been found in French North Africa. If the gas can be transported economically from North Africa to Europe, it may greatly improve the fuel situation not only in France but also in other western European countries, possibly including this country.

In the first of these lectures it was stated that world consumption of natural gas in 1958 was equivalent in thermal value to that of about 500 million tons of bituminous coal, and that four-fifths of the gas was used in the U.S.A. The corresponding coal equivalent of the natural gas used in 1958 was 30 million tons in the U.S.S.R., 10 million tons in Canada, 6·5 million tons in Italy, 5 million tons in Venezuela, and 1·3 million tons in France, leaving about 47 million tons coal equivalent for the rest of the world. Unfortunately, a search for natural gas in Great Britain during the last few years has been disappointing. Some natural gas has been found in Scotland and in Derbyshire, but the indications are that the reserves are too small to be of real importance. During 1958–9, the

British gas industry received 0·24 million therms of natural gas from one of these sources, largely as a test of the potential output of the well; this amount of natural gas is about one ten-thousandth of the gas sold by the industry.

In 1958–9 the petroleum industry in this country supplied to the gas industry about 50 million therms of refinery gas.

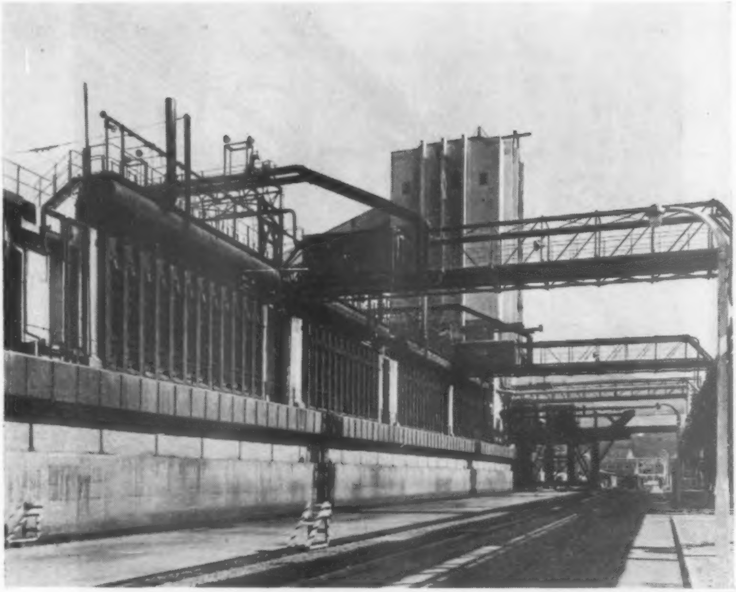
Methane, or natural gas, from coal mines is being used to augment public supplies of gas in some countries, including this country; but the quantities are relatively small. In this country, the amount at the present time is less than 10 million therms per annum, or no more than one-third of one per cent of the gas supply.

During the last few years, the British gas industry has made interesting trials on the transport by ship of liquefied natural gas from America. About a year ago, the first trial cargo of 2,000 tons or about one million therms was delivered at Canvey Island and discharged into tanks. The liquid was then gasified and conveyed by pipe line to Romford gas works, where the gas was reformed to provide gas similar to town gas. There have since been more trial voyages. Shiploads of only 2,000 tons are not economic, but the trials have shown the technical possibilities. The next step is the consideration of the economics of importing liquid methane on a much larger scale.

COKE OVEN INDUSTRY

For many centuries charcoal made from wood was used to convert iron ore into metallic iron. The carbonization of coal to produce coke to replace charcoal in the production of pig iron was first practised in Great Britain about 250 years ago. In the early days of the use of coke for this purpose, no measures were adopted to collect and recover the by-products gas, tar and ammonia evolved during the carbonization of the coal. By-product coke ovens designed to collect and recover the by-products were first introduced about 90 years ago, but the ironmasters who had become accustomed to using coke made in the older beehive ovens said that the coke from the by-product ovens was not so good for the blast furnaces. In consequence, the industry was slow in adopting the new methods of making the coke; and even by the year 1900 only 7 per cent of the metallurgical coke produced in this country was made in by-product ovens. Progress then became more rapid and by 1928 by-product ovens produced 94 per cent of the metallurgical coke made in this country; but many beehive ovens were still in operation until about two years ago, particularly in Durham, though the amount of coke they produced was relatively very small.

In modern coke ovens, the coal is carbonized to reach an average temperature in the region of 1000°C. This requires a temperature of about 1300°C. in the heating flues on the outside of the oven walls. Each oven, according to the particular design, may hold from 10 to 20 tons of coal, and the time of carbonization before the coke is discharged may be in the region of 20 hours. There are many ovens in a battery. At modern installations, the amount of coal carbonized may be 2,000 tons or more per day. Figure 8 gives a view of one side of a modern battery of ovens, with the machine for pushing out the coke



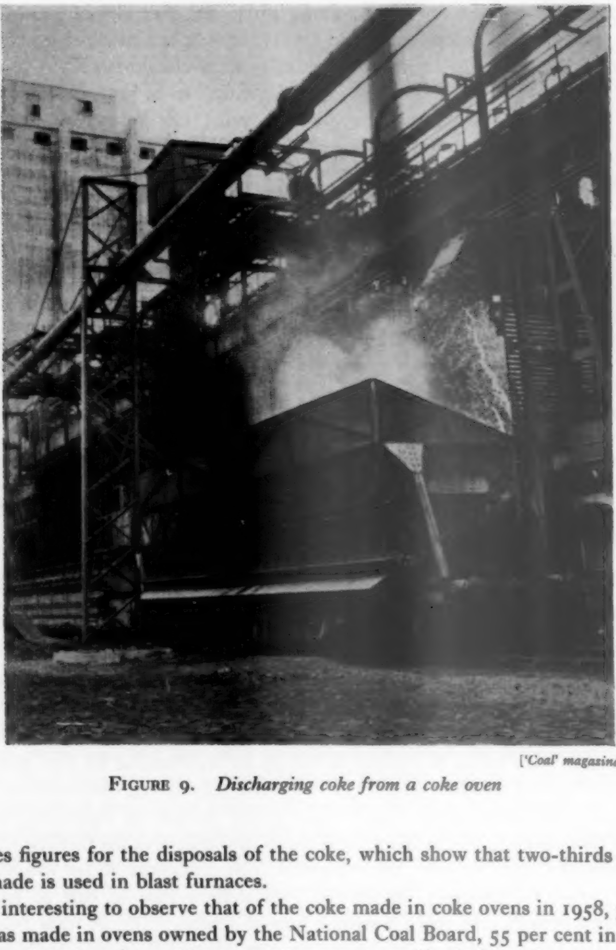
[National Coal Board

FIGURE 8. *A modern battery of coke ovens*

after the coal has been carbonized; and Figure 9 shows coke being discharged from one of the ovens on the other side of the same battery.

The amount of metallurgical coke required, and thus the amount of coal carbonized in coke ovens, is dependent mainly on the demand for iron and steel, which in turn is dependent on overall industrial activity. In consequence, there have been fluctuations from year to year in the amount of metallurgical coke made in this country, but with a general trend upwards over the last few decades as the iron and steel industry has expanded. The maximum so far was reached in 1957, when the industry carbonized 30·8 million tons of coal to produce 20·5 million tons of coke and 1·4 million tons of breeze. With the trade recession in 1958, the amount of coal carbonized in coke ovens fell to 27·9 million tons. Though there will no doubt be fluctuations from year to year in the future, it is probable that on average the iron and steel industry of this country will continue to expand over the next ten to twenty years and that the demand for metallurgical coke will increase, even allowing for further increase in the efficiency of using coke in the metallurgical industries.

The trend over the period 1948 to 1958 is shown by the figures in Table XIV for the amounts of coal carbonized and coke and by-products made by the coke oven industry in each of the years 1948, 1952, 1956, and 1958; the table also



['Coal' magazine

FIGURE 9. *Discharging coke from a coke oven*

includes figures for the disposals of the coke, which show that two-thirds of the coke made is used in blast furnaces.

It is interesting to observe that of the coke made in coke ovens in 1958, 37 per cent was made in ovens owned by the National Coal Board, 55 per cent in ovens at iron and steel works, and 8 per cent in ovens owned by independent companies.

GAS INDUSTRY

It was about 150 years ago that the carbonization of coal to produce gas as an illuminant was developed as a commercial proposition and the gas industry was founded. For many years the retorts were made of iron and the temperatures of carbonization were much lower than they are to-day with retorts made of refractory material, including silica bricks. With the lower temperature of

TABLE XIV

COKE OVEN INDUSTRY IN GREAT BRITAIN, 1948–58: COAL CARBONIZED; COKE, GAS, AND BY-PRODUCTS MADE

	1948	1952	1956	1958
Coal carbonized, million tons ...	22·3	25·2	29·5	27·9
Coke made, million tons	15·4	17·1	19·6	18·5
Coke breeze made, million tons ...	0·9	1·0	1·3	1·2
Disposals of coke, million tons:				
Blast furnaces	10·4	11·7	13·5	11·7
Foundries	1·1	1·2	1·2	0·9
Miscellaneous	3·9	4·1	4·7	3·7
Gas made, thousand million c. ft. ...	243	272	321	310
Used in coke oven plants	117	117	130	118
Used in steel works	49	68	84	85
Sold to gas industry	60	67	88	92
By-products made:				
Crude tar, thousand tons	860	970	1114	1079
Sulphate of ammonia, thousand tons	180	200	236	245
Crude benzole, million gallons ...	65	73	84	84

carbonization, the gas obtained contained more of the more complex hydrocarbons and was good as an illuminant when burned, but the volume per ton of coal was relatively small. The illuminating power of the gas when burned under specified conditions was for long the standard of quality and it was not until the Gas Regulation Act, 1920, that the therm (100,000 B.t.u.) became the legal measure for charging for the amount of gas supplied.

The gas industry now employs several methods of gas manufacture. These include the carbonization of coal to produce coal gas, the interaction of coke at a high temperature with steam to produce water gas (hydrogen and carbon monoxide), which may be enriched with the products of 'cracking' petroleum oils, the interaction of coke with air and water vapour to provide producer gas, the gasification of petroleum oils, and several systems of complete gasification of coal. The methods of coal carbonization may be divided broadly into two main groups. In one group the process is intermittent in that the retort, chamber, or oven is charged with coal, which is carbonized. The residual coke is then discharged and is replaced by a fresh charge of coal. This group includes horizontal retorts, intermittent vertical retorts and chambers, and inclined retorts. The other group includes continuous vertical retorts into which coal is continuously supplied at the top and coke is continuously withdrawn from the bottom of the retort. Figure 10 shows a range of horizontal retorts and Figure 11

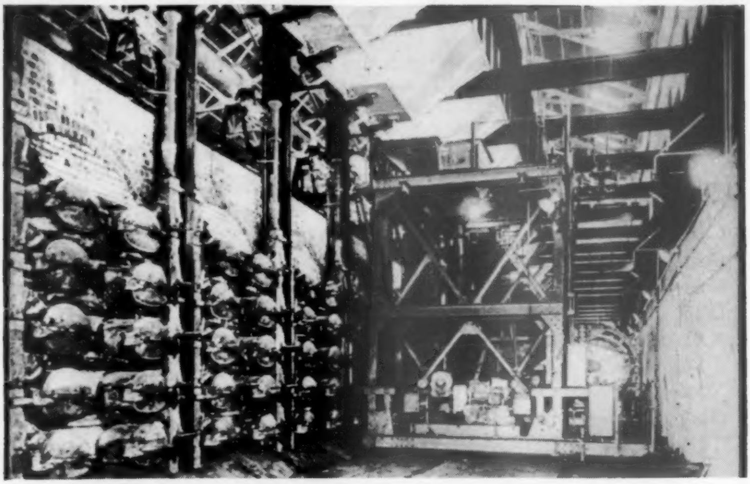


FIGURE 10. *Horizontal gas retorts*

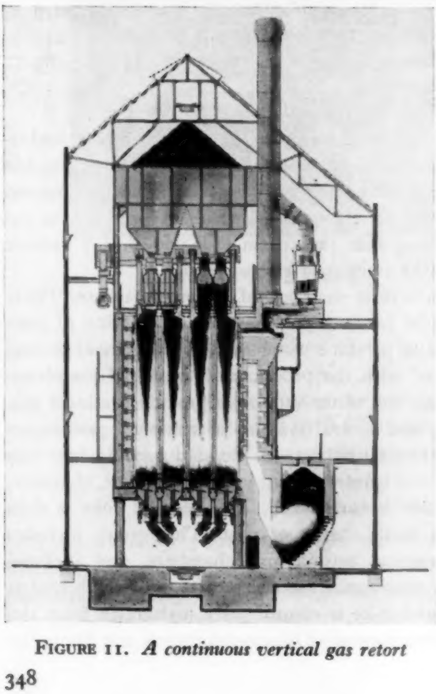


FIGURE 11. *A continuous vertical gas retort*

is a diagrammatic section of a continuous vertical retort to indicate the progress of carbonization as the coal moves slowly downwards through the retort.

At the present time, about 80 per cent of the gas made at the gas works in this country is coal gas, 17 per cent is water gas, including water gas enriched with petroleum oil, leaving only 3 per cent made by all the other processes. The gas made for the base-load demand is almost entirely coal gas; the water gas is used mainly to increase the supply to meet the peak-loads. More than 60 per cent of the coal gas is made in continuous vertical retorts. Of the gas available to the industry, about 82 per cent is made at the gas works, 16 per cent is bought

from the coke oven industry, and 2 per cent includes gas bought from petroleum refineries and from the coal industry.

The progress made by the British gas industry during the period 1948 to 1958 is shown by the figures in Table XV. Over that period, the annual sales of gas increased by 18 per cent. One-sixth of this increase was accounted for by an increase in the amount of coal and oil used and one half by an increase in the amount of gas bought, leaving one-third or 6 per cent of the gas made to be accounted for by an increase in the efficiency of production and distribution.

TABLE XV

GAS INDUSTRY IN GREAT BRITAIN, 1948–58: GAS PRODUCTION AND COKE AND TAR MADE

	1948	1952	1956	1958
Fuel used for gas making:				
Coal, million tons	24·4	27·7	27·7	24·8
Oil, million tons	0·46	0·44	0·49	0·66
Gas made, million therms:				
Coal gas	1762	2027	2083	1885
Water gas	327	345	354	410
Oil gas	—	—	6	32
Other gas	29	34	29	25
Gas bought, million therms:				
Coke oven gas	297	341	450	471
Oil refinery gas	—	7	10	37
Methane	—	—	1	5
Total gas available, million therms	2415	2754	2933	2865
Gas sold, million therms ...	2178	2453	2589	2574
Coke and breeze made for sale, million tons	11·3	12·9	12·9	11·3
Crude tar made, million tons ...	1·65	1·89	2·00	1·85

OILS AND CHEMICALS AS BY-PRODUCTS FROM COAL

When coal is carbonized as at coke ovens and gas works to produce coke and gas as the main products, there are obtained as by-products tar and ammonia. The gas contains benzene and associated compounds. At coke ovens and at some

gas works, these compounds are removed and recovered as benzole. In addition, if the gas is to be distributed for public supply, the hydrogen sulphide in the crude gas must be removed, and this process of purification leads to the recovery of sulphur, usually in the form of spent oxide containing about 50 per cent of iron oxide and 50 per cent of sulphur. The amounts of these several by-products obtained by the British coke-oven and gas industries in 1956 and 1958 are given in Table XVI.

TABLE XVI

BY-PRODUCTS FROM THE COKE-OVEN AND GAS INDUSTRIES IN GREAT BRITAIN IN 1956 AND 1958

	1956	1958
Coal carbonized, million tons:		
Coke ovens	29·5	27·9
Gas works	27·7	24·8
Total	57·2	52·7
By-products obtained:		
Crude tar, million tons:		
Coke ovens	1·11	1·08
Gas works	2·00	1·85
Total	3·11	2·93
Crude benzole, million gallons:		
Coke ovens	84	84
Gas works	28	24
Tar distilleries	8	12
Total	120	120
Ammonium sulphate, thousand tons:		
Coke ovens	236	245
Gas works	82	79
Total	318	324
Sulphur in spent oxide, thousand tons ...	270	250

The tar could be used as a liquid fuel, and a proportion is so used at steel works possessing their own coke ovens. Most of the tar is distilled to provide

products of greater value. The quantities of tar distilled and the amounts of the primary products obtained in 1956 and 1958 are given in Table XVII. The materials in the last five items of this Table are used as raw materials for a large variety of plastics and fine chemicals. The annual value of the primary products from the distillation of tar in Great Britain is in the range of £30 million to £35 million and the return to the coke ovens and gas works producing the crude tar is in the region of £7 per ton. The net amount received by the gas industry for tar is £12 million to £14 million a year, which is about 6 per cent of the receipts from the sales of gas; this industry makes little or no profit on the sales of benzole and ammonium sulphate and the return from sulphur does not cover the cost of purification of the gas to remove hydrogen sulphide. The by-product ammonia is in competition with ammonia made by the synthetic process.

TABLE XVII

PRINCIPAL PRIMARY PRODUCTS FROM DISTILLATION OF TAR IN GREAT BRITAIN IN 1956 AND 1958

	1956	1958
Crude tar distilled, thousand tons	2869	2722
Products obtained:		
Road tar, thousand tons	608	538
Creosote-pitch mixture, thousand tons ...	879	899
Pitch, thousand tons	534	512
Creosote oil, million gallons	103	93
Naphthalene, thousand tons	52	56
Phenol, thousand tons	13·6	18·6
Anthracene, thousand tons	2·8	2·3
Refined cresylic acid, million gallons ...	14·3	13·7
Pyridine bases, thousand gallons	348	379

OILS AND CHEMICALS AS MAIN PRODUCTS FROM COAL

So far, it has not been economic to establish any substantial industry in which organic chemicals are the main products from large quantities of coal as the raw material. As a main product from the gasification of coal and coke to produce hydrogen, which is then combined with nitrogen, large and increasing quantities of synthetic ammonia have been made over the last thirty years. Most of this ammonia has been used for the production of fertilizers, and some is used for the manufacture of nitric acid by catalytic oxidation.

Very large plants for the hydrogenation of coal to produce oils and chemicals were in operation in Germany before and during the 1939–45 war. By April,

1944, the rate of production of oils from these plants was 3·25 million tons a year of which more than one-half was aviation spirit. Costs were quite uneconomic compared with natural petroleum and the process was operated to reduce the country's dependence on important petroleum. Even using very cheap brown coal as the raw material, the cost of the motor spirit from the largest of the hydrogenation plants was more in 1938 than twice the cost of similar spirit from petroleum.

By the Fischer-Tropsch process, oils and chemicals are synthesized by passing a mixture of carbon monoxide and hydrogen over a catalyst at a temperature in the region of 180°C. to 240°C. The synthesis gas is ordinarily made from coal and coke. As with the hydrogenation process, large plants were operated for a number of years in Germany. By April, 1944, the rate of production reached the equivalent of nearly 600,000 tons a year, of which nearly one-half was motor spirit. This process is more suitable than the hydrogenation process for the production of waxes and raw materials for chemicals. It is quite uneconomic, however, in comparison with petroleum, particularly if the synthesis gas has to be made from coal at the price of coal in Great Britain.

A large Fischer-Tropsch plant designed to produce about 200,000 tons of motor spirit a year as the main product is now in operation in South Africa. For the production of the synthesis gas, coal is available at about 6*s*. a ton for this plant, the capital cost of which was £35 million to £40 million. Even with coal at this low price, it has not yet been fully established that the process is a real commercial proposition.

CHEMICALS FROM OIL

During recent years a prosperous and rapidly expanding chemical industry based on petroleum as the raw material has been established in the U.S.A. and in this country. A large variety of chemicals and raw materials for chemicals is being produced, and these materials are being used in the manufacture of plastics, fibres, detergents and many other products.

FUTURE DEMANDS FOR FUEL AND POWER IN THE UNITED KINGDOM

Over the ten years 1948 to 1958, the coal equivalent of the total annual consumption of fuel and power in the United Kingdom rose by 36 million tons from 212 million to 248 million tons. Of this increase of 36 million tons, 7 million tons was as coal, and 28 million tons was the coal equivalent of the increase in consumption of petroleum oils as fuels. If the same compound rate of increase continues during the next ten to twenty years, the coal equivalent of the inland consumption of fuel and power will be 290 million tons in 1968 and 340 million tons in 1978. Though this rate of increase is lower than the tentative forecasts of other writers of the last few years, the author does not think it will be exceeded and doubts whether it will be reached, after allowing for fluctuations from year to year. The author's guess is that by 1968 the coal equivalent of the inland

fuel and power consumption will be in the region of 280 million tons, or about 32 million tons more than in 1958. This additional demand will probably be met by the equivalent 12 to 15 million tons of coal as electricity from nuclear power stations, 10 to 12 million tons from the additional use of oil, and the remainder by the consumption of about 8 million tons more coal than in 1958.

Acknowledgments

The author is indebted to the Central Office of Information for Figure 1, the National Coal Board for Figures 3 and 8, the Magazine *Coal* for Figures 2 and 9, *Colliery Engineering* for Figure 4, the Gas Council for Figures 5, 10 and 11, and the British Petroleum Company Ltd. for Figures 6 and 7. The data in the tables have been derived from various sources, particularly from the Statistical publications of the Ministry of Power, the United Nations, and the World Power Conference.

IRRIGATION AND POPULATION IN CEYLON, INDIA AND PAKISTAN

A paper by

R. MACLAGAN GORRIE, D.Sc., F.R.S.E.,

read to the Commonwealth Section of the Society on Tuesday, 26th January, 1956, with Sir Harry Lindsay, K.C.I.E., C.B.E., a Vice-President of the Society, in the Chair

THE CHAIRMAN: Dr. Maclagan Gorrie is no stranger to us, because twice before he has addressed this Society. Prior to the Partition of the Indian sub-continent he was a member of that great service, the Indian Forest Service, and there during his time in the Punjab he became an expert on subjects such as those he is going to examine this evening—irrigation, soil conservation and erosion. After 1949 he maintained his interest in the East, and placed his expert knowledge at the service of the Food and Agricultural Organization of the United Nations, of the Colombo Plan Authority, of the Water and Power Development Authority of West Pakistan and of the Foreign Office. He is the author of a book entitled *Soil and Water Conservation in the Punjab* and of many articles in periodicals specializing in these subjects.

The following paper, which was illustrated with lantern slides, was then read.

THE PAPER

Most people think of irrigation as a sort of magic carpet on which the starving millions of the undeveloped countries can be borne to agricultural prosperity. But the damming of a river is a comparatively simple and straightforward task as compared with the other problems which go fore and aft of the ponding operation. If the dam gets silted up it becomes useless. If the irrigated land is not drained it gets water-logged or poisoned with salt.

As I am not an irrigation engineer, I propose to deal with this title, 'Irrigation and Population', on the widest possible basis, and would ask your indulgence while I attempt to analyse some of the implications of water supply in arid lands, and the effects upon the population of alterations in the water supply conditions. The engineers always have faith to believe that each new project which they plan and build is to be a permanent and indestructible asset to the community, but one can enumerate many examples of great works passing out of use, not through any failure of the work itself, but through other human or biological factors. There are the sad relics of the great Mesopotamian irrigation schemes of two to three thousand years ago which went out of use through the salt poisoning induced by the Tigris water being used without any drains. Similar but less ancient works of Buddhist engineers in Ceylon, now being reconstructed, lapsed into disuse through malaria. Modern designs in the Punjab canals are showing

losses of many thousands of acres a year ruined by a rising water-table causing water-logging. Many modern works in America and Algeria have already been rendered useless through the silting of the reservoir 'ponded area' by severe soil erosion from an upland catchment, or are only being kept open by very expensive dredging. France has only recently produced an example of the failure of the Fréjus Dam, the cause of whose breaching is not yet known, but which has brought disaster rather than happiness to the water-using community. In making these points I should like to make it clear that I am not denigrating the dam-builders, for I have the greatest respect and admiration for their designs and achievements.

At the present time the demand for water is so universal that sites for dams are being chosen which a few years ago would have been avoided because of the problem of evacuating the people from the dam site. On the other hand the bulldozer and other modern aids render the work of both dam building and rehabilitation simpler and quicker. I propose to take three modern projects and analyse their effects upon population movement and welfare as conditioned by the non-engineering factors in each case:

1. The Gal Oya project in the arid south-east corner of Ceylon.
2. The Damodar Valley Corporation régime in Bihar with its four large dams.
3. The Mianwali Thal project and the water problem in West Pakistan.

My choice of these three is governed by my own first-hand knowledge of them, but from reading and discussion of African and Australian projects, they seem to provide a fair amount of common ground. Before dealing with each of these in detail, however, I should like to enumerate some of the points which I am trying to bring out, and which can be summarized under three headings, namely:

(i) the value of water as a resource which has its own specific value to the community and should therefore be used with economy and intelligence:

(ii) the engineers' investment should be measured in human happiness, rather than in cash returns;

(iii) big canals mean big wastages.

The value of water as a basic resource is important in many ways apart from irrigation; its potential for hydro-electric power production and its management as a factor in flood control must be appreciated in the planning stages alongside the fuller development of the upland agriculture. There is comparatively a simplicity in the actual engineering job as contrasted with the adjustments in human values which a major dam introduces. Upstream engineering in its widest sense should ensure that the best land uses are developed in the catchment as a whole; for instance there is a potential value to upland agriculture of the vast areas of deeply ravined land in the Siwaliks, the Punjab and Bihar, which in their present state form a major source of silt-laden floods.

In the case of each major dam project the whole catchment should be surveyed by an erosion team, preferably with a set of air photos from which the erosion hazards such as poor terracing, disforestation, active land-slides and ravined areas can be much more accurately assessed than by ground reconnaissance

alone. With this and some silt-load measurements taken during high floods, some assessment can be made of the silt potential and the 'sore spots' from whence the silt is derived. Incidentally, the silt-load cannot be given realistically or accurately by taking a lot of daily or annual averages, but must be considered in the context of the occasional catastrophic flood which picks up not only spectacular loads of suspended silt, but also moves along a bed-load of heavier debris, the analysis and measurement of which has so far defeated the best efforts of the hydrologists. In severe floods a major river churns up its bed to great depths, and so the whole bed is on the move. The usual 10 or 15 per cent allowed for bed-load is not realistic in such conditions.

Major engineering projects are quite rightly assessed by accountants on their capacity to earn profits. A budget is prepared to show that the investment will be secured by the cash returns over a limited period of years, but what if the investment runs down after that through silting or other deterioration such as increasing salinity? Is the ultimate end in human misery and disappointment not to be discounted against the earlier profits? Would it not be sounder finance to spend some reasonable percentage of the dam's cost in putting the catchment into proper order with such simple and obvious precautions as the better terracing of steep hillside cultivation, the reduction of excessively heavy goat browsing, and the provision of up-to-date fire-fighting equipment to deal with forest fires? The investment value could be more accurately assessed if the goal were taken to be, not the cash return from the first 20 or 30 years, but a contented and stable population in possession of the irrigated land in 100 years' time. To quote Georges Drouin, an eminent French dam constructor, in his summary of findings in the 1951 International Commission on Large Dams: 'There is torment in the thought that great human achievements, productive of safety and well-being, depend on works whose expectation of life is confidently estimated at less than two generations. The problem which faces us here would seem far more important, humanly speaking, than any of those technical questions of construction to which it may now be said satisfactory answers have been found.'

The initial dislodgement of the occupants of the area which is to be flooded behind the dam is the first of many major upheavals; these people have to be rehabilitated somewhere or other before the irrigation can be laid on for the new land below. They are usually hill folks who do not relish being transplanted to a new climate, and it should be possible in some cases to accommodate them on uplands in the immediate neighbourhood of the dam by bull-dozing fresh terraces for them. This was done successfully in the case of the Damodar and should be equally feasible at the Mangla Dam. At a later stage there is need to prevent the sub-division of holdings below the economic minimum, and this can best be done by using the same type of legislation as is being used to implement the consolidation of holdings. There must be enough land and irrigation water to give each family unit an economic holding of crop land plus a modicum of fodder for the cattle, either in terms of grazing land or cultivated fodder crops.

And here let us note the exceedingly wasteful use of irrigation water on good land to produce a mediocre crop of wheat, barley or other small grains, when the

same water and soil could produce fruit, vegetables and other highly lucrative and valuable crops. This stepping up of the productivity will require a little extra trouble in laying on some 'extension' teaching and demonstrations of the requirements of these various crops, and a cheap and reliable supply of nursery stock.

Big canals mean big wastages of water, not only in the sense of unworthy crops and poor returns from the water used, but also in the misuse of water poured out on land which is already heading obviously for water-logging, when severe restrictions on water use, and possibly a drop from two crops a year to one would at least postpone disaster, if not avoid it entirely. Also in terms of the waste water which runs through the canal system but cannot be utilized fully, this could in fact be used in flooding adjacent arid tracts which are normally out of reach of either rain or irrigation. Where irrigation forestry is practised, the technique is apt to be very highly stylized, as in the Punjab irrigated shisham plantations, so that when foresters get an offer of erratic flood irrigation of this sort, they reject it. There is an urgent need for foresters and irrigation engineers to co-ordinate so that such opportunities for raising tree crops on waste land are fully exploited. And this need not conflict at all with efforts to reduce water-logging and salinity in the areas where these are threatened.

This lecture constitutes a plea for the fuller development of the uplands with their rain-fed crops, for it is in the proper management of the uplands under sound agriculture and forestry that we find the hope of a permanent prosperity by making the best use of the rain wherever it falls. The highly organized and concentrated canal irrigation from big dams can only be maintained over long periods if water conservation is started upstream, and the run-off is fully controlled before it reaches the main reservoir.

GAL OYA, OUR CEYLON EXAMPLE

During three years as Soil Conservation Officer to the Ceylon Government, 1950–52, I was called on to report on several dam and irrigation projects, including the Gal Oya, the Kelani and the Walawe, the Kotmale landslips of 1947, and on the various commercial plantation industries. The Gal Oya dam was then being built and came into use before I left. It is an earth dam forming a 'ponded area' of some 30 square miles of shallow reservoir with a capacity of some ¾ million acre-feet. The water is used to generate electricity and to irrigate some 100,000 acres in the dry south-east corner of the island, land which was previously only partially developed on a one-rice-crop régime.

The development has been steady and highly successful; the Gal Oya Development Board has established 40 new villages of 150 houses each housing 8 persons. Each family unit of land is self-supporting with paddy as the main crop, but with a share of non-irrigated land for cattle grazing. A block of 4,000 acres of sugar cane has been developed to supply a sugar factory at Amparai which is being fitted with Scottish machinery. In addition to the original scheme for trapping and using flood water behind the main dam, six smaller dams have been built on tributaries to store an additional ¼ million acre-feet of flood water

Steep slopes have largely been disforested to clear the ground for cultivation, but unfortunately it is of the shifting type, so no terraces are made. The soil losses from such places in Gal Oya, and in fact throughout the undeveloped areas of Ceylon, are very heavy

which is now available for village crops. These subsidiary dams were not foreseen in the original scheme but were found to be essential to protect the other local developments against flood damage. My own small share in the Gal Oya was to trumpet the dangers of erosion so that the local newspapers labelled me as a prophet of doom. The technicians responsible for land management in the catchment have since been delightedly pointing out that nothing has happened in the way of the disastrous silting which I prognosticated. Even the December 1957 flood which swept away nearly all the sluices and subsidiary dams, left the main reservoir happily intact and apparently not very seriously silted.

I should, however, point out that the set of conditions I visualized as being dangerous have not so far been encountered. The drainage area for the dam is 350 square miles, starting from a tremendously steep scarp face falling from 4,500 feet on the Uva plateau to a maze of rocky hills below 1,200 feet. Roughly half the area is parkland and open forest, and a further 40 per cent is of slopes from which the jungle has been destroyed by shifting cultivation with crops grown in the ashes of burnt forest. The worst feature is the grassland fires which

inevitably sweep through much of the area towards the end of the dry summer season. Now, if a particularly dry summer with widespread fires leaves the whole place with an unprotected layer of ash, and the monsoon starts off with a particularly heavy initial storm—instead of the usual light showers which normally allow the young green grass to take possession of the bare ground—the amount of silting is likely to be immensely heavy. Even once in 10 or 20 years, a silt deposition of 100,000 acre-feet behind the dam is possible, and could ruin the financial prospects of the project, so I have urged that the park-land should be afforested, preferably with irrigation laid on to assist the early stages of afforestation, and with up-to-date fire-fighting equipment and organization laid on. None of this has yet been done, and the menace of grass fires remains.

Apart altogether from the danger to the dam of these continuing grass-fires, the obvious use for this rolling foothill country is not grass but forest. Of course the rising pressure of population for Ceylon as a whole makes it increasingly difficult to get any specific area allocated to forestry or wild life protection, even where the incidence of population in that particular area is still low enough to make shifting cultivation for a few jungles a feasible proposition. What complicates the issue is that shifting cultivation by the destruction of forest has become a fashionable and profitable pursuit for sophisticated townsfolk.

THE DAMODAR VALLEY, OUR EXAMPLE IN CENTRAL BIHAR

Since about 1860 the Damodar, 'the river of sorrow', has been the subject of much planning by way of flood prevention schemes, because its floods have been a constant embarrassment to West Bengal downstream. In 1945 a Dutch engineer, W. L. Voorduin, with previous experience in the Tennessee Valley Authority, produced a project for 4 dams for electric power and irrigation, plus a coal-burning generating station to cost 40 crores of rupees, or about 30 million pounds sterling, but by the time the work was undertaken in the early '50s, it cost nearly four times as much. One heavy charge which had not been foreseen was the terracing by machine of the sloping lands onto which the dispossessed people from the reservoirs were rehabilitated; in spite of good accommodation in the new villages and a just provision of prepared land, the transfer met with a great deal of opposition and boycott from the evacuees.

The engineering programme has gone through well, and the four dams are now functioning in serving West Bengal with irrigation and power, but very little has yet been done to put the 7,000 square miles of highland catchment into anything like erosion-proof condition. The Chota Nagpur plateau in the neighbourhood of Hazaribagh is terribly cut up by the gullying of the loessal cap of good soils, and the resultant storm run-off takes a phenomenal load of silt down into the reservoirs with every major storm. During a six-months' assignment under the Colombo Plan in 1953–4, I prepared an erosion control and afforestation scheme, which emphasized the need for the reconditioning of a million acres of village *sal* forest which had been almost totally destroyed by previous misuse, as it was outside the operation of the Indian Forest Act, and was in a quite shocking condition from fire and over-grazing. Out of the 40 sub-catchments,

Upland sal forest in the catchment of the Damodar dams destroyed by over-grazing, fires and erosion. About a million acres of village sal forest contribute silt to choke the reservoirs

work has actually been taken up in one near Hazaribagh, and elsewhere some afforestation is going on, partly under the Corporation's own forest staff, and partly under the Bihar Forest Department. But the extent of these works is quite inadequate, and the main sources of silt from the cultivated uplands and eroding ravines remain unchecked. Various estimates of the rate of silting have been made, including one from the irrigation staff which gave the life of the Maithon Dam as 25 years. Even if this has been shot down by other engineers' estimates which suggest around 100 years' life, the position is sufficiently alarming. If the end result of all this vast expenditure and reconstruction is merely to mean that a few million people are to be given a better standard of living for a few years and then have it gradually withdrawn again through failure of the water storage capacity, it really does not seem to be worth the immense effort which has gone into it. The cure, or rather the prevention, lies in a reasonable programme of soil conservation for the 7,000 square miles of upland catchment. This should be based upon the five main issues:

(*a*) better field terracing,

Mianwali Thal, irrigated for the first time by Indus water from Daud Khel canal in 1948. The trenching and water distributors had been completely wiped out by a wind storm when this photograph was taken in May, 1949

(*b*) reclamation of gullied lands,
(*c*) construction of farm ponds and minor irrigation projects,
(*d*) afforestation of the destroyed forests,
(*e*) a rigid control of grazing with a reduction in the herds and a big drive to produce better fodder crops and better animals.

All these should be well within the capacity of the D.V.C. technical staff of land use and soil conservation technicians, who are probably the most highly qualified group in the whole of India, but the D.V.C. as a body seem strangely lethargic about this, although their record in engineering has been a good one. Their administrative machine is modelled to some extent on the Tennessee Valley Authority in the U.S.A., but political influences have produced more of a parody than a model. It set off in 1948 with a semi-government body, a triumvirate with full powers, but they soon found themselves subordinated to a financial pundit who took complete charge of the spending. A heavy programme of upstream reservoirs has been all but abandoned. No powers have been authorized to compel terracing. The responsibility for the management of the

Sand dunes in Mianwali Thal partially anchored by afforestation with Tamarix, Calligonum and Saccharum grass. December, 1959

upland catchment in terms of agricultural 'extension', afforestation, grazing control, animal husbandry, torrent correction work and the use of available machines for the reclamation of ravines, has been bandied about between the Government of India, the Bihar State and the Corporation, so that even at this late date very little effective action has been taken by any of them. It is a sad and frustrating story.

THE MIANWALI THAL, OUR PAKISTAN EXAMPLE

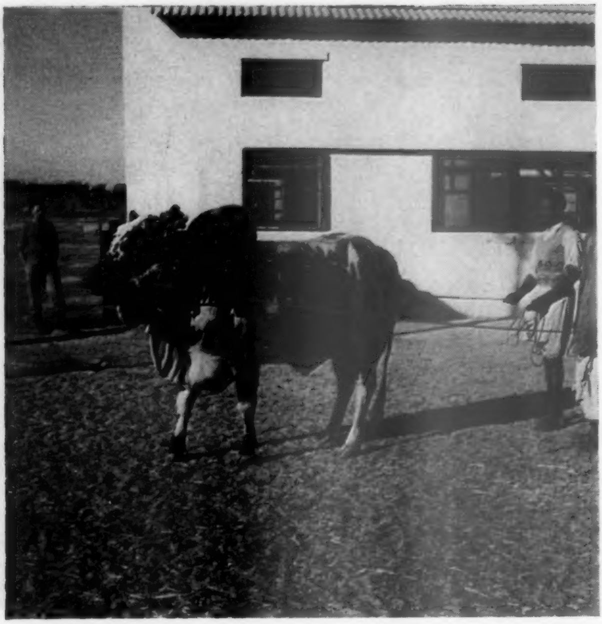
Eleven years ago the Mianwali district was a desert, as the name *thal* implies. In the summer of 1948 the water was brought into it from the newly completed Daud Khel barrage on the Indus, and forest plantations were started as part of the settlement project. Twice in May of that summer the channels and distributaries built through the sand dunes were completely swept away by wind and obliterated, so we had to start all over again next morning. It seemed a hopeless task to conquer these miles of sand. In 1948 there were only two land-use classes, namely fixed dunes and shifting dunes, both of them equally intractable. To-day the whole tract is settled; it has many citrus gardens, several

Mianwali Thal six-year-old Dalbergia sissoo irrigated plantation with its first thinnings stacked. December, 1959

thousand acres of sugar cane, an excellent livestock farm, and plenty of wheat. It is in fact a miracle; the very small part I had in its early stages has given me enormous pleasure, confirmed by a flying visit only a few weeks ago.

Unfortunately there is a snag. The water-table level has risen from 70 to to 7 feet in the ten years. There are already signs of water-logging as well as the building up of salt exudations on the surface just ahead of any actual water-logging. The main canals and the subsidiary channels should of course have been lined to reduce the seepage, but this was not done at the time of building, and once a canal is in use, it is much more difficult to get such work done as an improvement because it means cutting off a whole season's irrigation supply. It will need drastic and heroic measures to cope with the present menace.

Forty years ago the canal engineers in the Punjab Irrigation Research were advocating the use of tube-wells in series along the channels where seepage was worst, to pump the water up from the rising water-table, thus checking its accumulation underground and making the pumped water available for use farther downstream. But very little was done in the British régime prior to Partition in 1947, by which time land was going out of cultivation at an alarming



Mianwali Thal: a prize Dhanni bull raised by the Thal Development Authority's cattle farm at Rakh Ghullama. December, 1959

rate, variously stated as being 30, 40 or even 50 thousand acres a year for the undivided Punjab. Since then various efforts have been made on both sides of the border, but nothing effective has yet been done in spite of offers of help from American sources. The most sensible course would appear to be the old Egyptian one of cutting your losses and reducing the irrigation from two crops to one a year, thus giving the land and the water-table time between harvests to settle down. This is, of course, a very drastic remedy and one which only recommends itself to those whose land is actually swamped and salty.

In the Thal there is still a high proportion of uncommanded sand-dunes which are now mostly segregated in small patches amongst levelled fields and are well anchored down with sand-binding bushes and grasses. The larger blocks of uncommanded land have been made over to the Forest Department to afforest with shelter-belts. Unfortunately the original plan for the afforestation of one-tenth of the whole Thal area, about 150,000 acres, was not persisted with, but was reduced as a result of interference from politicians who forced government to hand out the bulk of this land to prospective settlers. The whole scheme is therefore less well provided with shelter-belts than was originally planned, but

Cutting sugar-cane on the Punjab Industrial Development Corporation's farm near Jauharabad, Mianwali Thal. December, 1959

on the whole it is astonishing how the menace of wind has receded. Some of the larger blocks of shifting dunes are still being fixed and afforested, and strict control of grazing and browsing is essential.

Irrigation in West Punjab as a whole has been severely handicapped ever since Partition in 1947 through the loss of the eastern canal systems to India. It is good news, however, that the World Bank has at last obtained agreement in principle between the two countries on the allocation of their water resources. Pakistan is to have help in building the two proposed dams, one at Mangla on the Jhelum and the other at Tarbela on the Indus, and the water from both will eventually be diverted into what are now the easternmost canal systems from the Chenab river and what is left of the old Upper and Lower Bari Doab canals from the Ravi river, though the water of the Ravi itself has been allotted to India.

My recent visit to Pakistan was to help in the preparation of a soil erosion survey for the Mangla Dam, whose catchment (12,000 square miles) lies half in Pakistan and Azad Kashmir, half in the Indian-occupied part of Kashmir. The silt-loads carried by the Jhelum and its tributaries when in high flood are

spectacular. Land-slides are a fairly constant feature in the high hills of the inner valleys, particularly along the Jhelum itself and in the Kishanganga, which has now been re-named the Neelum. The greatest single factor, however, is the heavy goat browsing in the lower outer hills, which are mostly of the very friable and erodible sandstones and shales of the Murree series and of the Upper and Middle Siwalik beds; the destruction of forest here, and in fact the entire destruction of all plant cover from large tracts, will have to be taken up for drastic control and re-planting measures at village level, and the quality of field terraces on very steep slopes improved. Apart from Java and Sumatra there must be very few mountains in the world which carry such a heavy population per square mile as do these outer hills of Punch, Bagh and Rawalakot in Azad Kashmir. Some of the people will perforce have to be moved out, as the town of Mirpur will come under the flooded area behind the dam, and they will have to be catered for either by bull-dozing the nearby uplands to make them into terraces for rain-fed crops, or else given irrigated land elsewhere in West Pakistan. Apart from this bulldozer rehabilitation, however, there remains the much larger problem of persuading the hill peasantry to adopt a better type of terrace wall for their fields on exceedingly steep slopes, because there can be no question of moving them all out. It is a gigantic task, and one can only hope that the World Bank and its observers will insist upon it being carried through as an intrinsic part of the engineering programme. It augurs well that the erosion survey was called for by the British firm of consultant engineers who are in charge of the design and construction of the dam itself.

While emphasizing the need for such surveys of erosion and flood conditions in the underdeveloped countries, it is only fair to say that Britain has almost run out of soil conservationists. Twenty years ago there were many men with a forestry background who could undertake such work, but in the interval they seem to have disappeared. When a post is advertised now, the only men with paper qualifications come from American universities which give a degree in this new science. Considering the great need for such work to be undertaken in our own Commonwealth countries—not excluding Scotland as one of the underdeveloped ones!—it seems a great pity that Britain has not maintained the supply of trained workers. They are badly needed.

DISCUSSION

THE CHAIRMAN: We have had a most interesting lecture, on an important and complicated subject. May I also congratulate Dr. Gorrie on the illustrations?—they were perfectly charming. Now I am sure there must be many present who will wish to take up with our lecturer points of special interest in his paper.

MR. KENNETH MORFORD, C.B.E.: Dr. Gorrie was pessimistic about the results of his recommendations in regard to soil conservation. I should like to ask him if he is not very satisfied with the progress which has been made in Ceylon as a result of recommendations which he made there? The general principle followed there now is to adopt a certain area at a time, proclaim it as an erodable area, and then set to work following almost exactly the lines Dr. Gorrie indicated; and although it is only four or five years since the regulations were brought in, the success achieved is really

remarkable already. Does Dr. Gorrie not feel that that is a very good preliminary plan which he could persuade other governments to examine? I should like to add, too, that the Co-ordinating Committees of the Irrigation, Forest, Agricultural and Private ownerships are working very well and help those concerned to achieve the objects without friction.

THE LECTURER: A fair question. From what I hear—and mind you, I have not seen it myself since 1952—the progress in Ceylon has been exceedingly good. The boys we helped to train have been attached to the Tea Research Institute, and from there have gone out through the island and have done an exceedingly good job of work in what the Americans call 'extension agriculture'. The success, so far as it is a success, I think is very largely due to the tremendous co-operation I got from the tea planters. When I went there I was a little afraid of meeting such a phalanx of specialists in their own line, and I was astounded at the welcome I got from the tea planters and the amount of work that they put in on precautions to stop the soil from getting away. I think it is as a result of the pattern which the tea planters then set that the rest of the island is now apparently making a fairly good job of it.

MR. P. K. SHAHANI: I think the lecturer is quite right in saying that attention should be paid to the fuller development of the uplands, and he is also right in saying that the work of the engineers should be judged by the human happiness that it generates. Does he not feel that the irrigation plans should be geared to the plans of the country as a whole—to the national plan, which in turn should be geared to the plans for, say, population control? How far does he think that the Indian Five Year Plans and Pakistan's new Five Year Plan conform to this?

THE LECTURER: I should obviously know more about my subject, irrigation and population, than I do! I am afraid that I cannot answer this question adequately. I have the greatest admiration for the Five Year Plans which have been worked out both in India and Pakistan, and which to a great extent have been successfully followed through. In fact, India is now embarking on her third. These plans over a given period are obviously of enormous value in guiding all the departments and all the activities in the direction in which they should go. Just how far the incidence of population can be affected by schemes of this sort is problematical. The theme that I started with was that irrigation is by no means the whole answer. So many of the older irrigation schemes are being kept alive only because of heroic efforts by the engineers that one is perhaps a little sceptical about the extent of the ultimate advantage to be derived from irrigation when its immediate effect is to increase the population.

MR. AMIR AHMAD KHAN (Conservator of Forests, Rawalpindi, Pakistan): The learned lecturer is indeed an authority on the subject of land use and related human problems, particularly in Ceylon and India and Pakistan, and he has dealt with the subject admirably. At the end of his paper he touched on a very important subject which worries those countries—that is, the availability of well trained and experienced staff. There are too few technicians in any of the universities who know the language and the connected social economic problems, for training these men. The commercial firms are also finding it difficult to find the staff. I wonder if Dr. Gorrie could suggest a way of keeping up the numbers of experienced officers with the necessary knowledge and the background? At the moment it seems that when the old officers with experience die out perhaps there will be no one to succeed them. I am aware that in these countries there may not be a need for pure administrators, but certainly there is a need for technical experts. They are needed really as missionaries, and Dr. Gorrie knows how welcome he is in this capacity when he goes to work in the wildest parts. He remarked that he may not again be invited to Delhi. I am not an Indian but I know Indian people, and I assure him they would honour him, and he should rest assured

that we in Pakistan would welcome being told by him where we go wrong. It is men like Dr. Gorrie and other experts who can help us.

LIEUT.-GENERAL SIR THOMAS HUTTON, K.C.I.E., C.B., M.C.: My recollection is that before Partition there was quite a considerable programme—considering the resources available at the time—for putting in tube wells; in fact, there was a special organization set up for the purpose. But I think that the emphasis at that time had to be on producing more food, and therefore the tube wells programme was concentrated much more in those places where it would immediately produce bigger crops than in the places where you have got water-logging and so on, where the tube wells are needed to correct the tendency for land to go out of cultivation. A certain amount was done there, however, and I think that set the pattern for what was done on a much larger scale afterwards. Perhaps Dr. Gorrie will correct me if I am wrong?

THE LECTURER: I am glad of the opportunity to correct my sweeping statement that little had been done under the British régime. Quite a lot had in fact been done both by the official research workers at Lahore and by the individual canal engineers themselves. I think the questioner is correct in saying that the earlier efforts were directed at crop production rather than at overcoming the overall menace of water-logging. There was a great deal done by the research people, and Mr. Crump (who is here) actually worked at this problem and has possibly since contributed from the Commonwealth Hydrology Research Unit in Britain. What I think should have been a really magnificent contribution was the American gift of material and money for the construction of tube wells in the early '50s; from what I have been told, these have not been effective.

LADY CHATTERJEE, O.B.E.: I think the 'Freedom from Want' campaign has a bearing on this problem. Under the circumstances would not the expanded technical assistance programme be ready and willing to give aid through technical assistance both to India and Pakistan, if they applied for it?

THE LECTURER: I really do not know enough about the organization of the 'Freedom from Want' movement to see how far it can contribute either to the question of training people or of providing working projects in the field. Training should be, and in fact is, quite well looked after already by the Commonwealth and the Fulbright scholarships and other means of that sort. F.A.O. also is now training people. But so far as Britain is concerned, there does not seem to be any organized attempt to get people trained as soil conservationists, and that is the point which Mr. Khan took up in his remarks just now. I think really the answer is, more and more scholarships so that more and more people from these underdeveloped countries can in fact acquire the training and experience themselves and deal with these problems as they come. A certain amount of technical advice from our side will, of course, be necessary for years to come, but I think the main effort must come from amongst the younger generation in these countries themselves. Just how far that links up with the 'Freedom from Want' campaign I really do not know.

MR. A. R. B. EDGECOMBE (Messrs. Haigh, Zinn & Edgecombe, Consulting Engineers): I should like to congratulate Dr. Gorrie on his splendid talk. The slides were excellent and brought back many memories. I have recently returned from Pakistan. Our American colleagues there were under the impression that very little was done to try and stop water-logging in the irrigated areas; on the other hand they had never seen such marvellous records of the fluctuations of the ground water. When irrigation was introduced into a new area, lines of wells were laid out across the country. These were used to observe the levels of the sub-soil water twice a year, at the beginning and the end of the monsoon. If a sustained dangerous rise was observed, the idea was that the area would temporarily be closed down for irrigation. In theory that was all right, but in practice, with an immense growth of population on the

area, it simply could not be applied. Dr. Gorrie mentioned the restriction of cropping. This again would be extremely difficult to apply. But I hope that the audience will not go away with the impression that in the India sub-continent no success has attended measures to prevent water-logging.

THE CHAIRMAN: Those of us who had heard or read Dr. Maclagan Gorrie's two earlier lectures to this Society knew that they could expect a high standard, and we have had it.

Now I just want to illustrate what I said a little earlier about the importance of this subject by quoting to you something that Mr. Bhabha, Chairman of the Indian Atomic Energy Commission, said not very long ago. These are his words:

> The rate at which the production of food can be increased is far greater than the rate at which the population increases, which is 1·3 per cent per annum in India. I emphasize that point because many people are under the misapprehension that the over-population in the under-developed areas is the cause of their own standard of living. This is clearly not so. Even with increasing population, modern technology enables one to raise the standards of living of the people as a whole because . . . the rate of increase in production is much greater, or can be much greater, than the rate of increase of population.

I only quote those words because they have such a bearing on the whole subject Dr. Gorrie has raised—the objective of which obviously is to increase the productivity of the soil and therefore to counter the effects of over-population.

May I ask you now to join me in a hearty vote of thanks to Dr. Gorrie?

The vote of thanks to the Lecturer was carried with acclamation, and the meeting then ended.

GENERAL NOTES

RELICS OF THE 1760 EXHIBITION

To mark the resumption on 3rd March of its annual Reception and *Conversazione*, which was honoured by the presence of H.R.H. the Duke of Edinburgh, the Society showed in its new exhibition room overlooking Adam Street a small, historic collection of pictures and objects of art which could be traced fairly certainly as having been included in the very first British exhibition of contemporary art, with which the Society was associated in 1760. The collection obviously stirred the historic sense of our Royal President and the several hundred Fellows assembled. Indeed, the passage of time seemed illusory in the almost palpable presence of Reynolds' sitters, who could be imagined joining the jostling crowds in the Society's Great Room in the Strand where their portraits were first publicly seen two centuries ago. Naturally the exhibition was a co-operative enterprise, and the evening's success was due as much to the enthusiasm and skilful hanging of Mr. William Johnstone, the Principal of the L.C.C. Central School, as to the preliminary researches of the Society's Curator-Librarian among the files of the Courtauld Institute and other sources. At the same time, it is plain that the way is open to an art historian to investigate at length the all too sketchy catalogue of 1760 in identifying and tracing all the 192 items now widely dispersed and sometimes perhaps lost, and reanimating some forgotten personalities of the time.

One half-forgotten personality, touchingly recalled on this occasion, was Richard Leveridge, a once celebrated vocalist, song-writer and composer, whose mobile countenance under an old Queen Anne wig was painted towards the end of his long life, and evidently in the late evening of the artist's, Thomas Frye, who died in the Exhibition's year, 1760. Frye's half-length portrait (from Warwick) was handled with something like Hogarthian liveliness, with touches of green and russet in the fluent modelling of the features, and breathing that compassion which an old artist feels for a kindred spirit in adversity whose powers have long since decayed.

[*By permission of Mr. Anthony de Rothschild*

Lady Elizabeth Keppel, later Marchioness of Tavistock, by Sir Joshua Reynolds

The jewel of the exhibition, nevertheless, was the portrait which Reynolds—with no forethought for inquisitive posterity—tantalizingly entered in 1760 as *A Lady, Three Quarters*. Happily the Dark Lady can safely be identified with the Lady Elizabeth Keppel, daughter of the second Earl of Albemarle, and at the moment when Reynolds painted her with a rose at the breast of silvery lace dress, still some years away from her youthful marriage to the Marquess of Tavistock. The graceful solidity and repose of this portrait (now in Mr. Anthony de Rothschild's hands) bespeak a studiousness quite different from the temper of Gainsborough. Even so, if there is nothing approaching that feathery sensuousness of touch which can mysteriously link a Gainsborough with a shimmering Renoir, in spirit at least this Reynolds presentment looks forward a hundred years. Reynolds' characterization of General William Kingsley, on the other hand, betrays a less secure grasp of form, though the photographs exhibited (in the absence of the paintings) of the sumptuous full-length of the Duchess of Hamilton and Argyll, and a study of a Lieutenant of the Tower in a Van Dyck pose, indicated the splendour of the contributions of the Academy's first President to the first exhibition of his contemporaries.

Together with the portraiture—which also included Richard Cosway's familiar portrait of William Shipley, the Society's Founder, besides a vital and substantial

pastel study by Francis Cotes, and Roubiliac's terra-cotta model of Shakespeare done for the eloquent marble to Garrick's order—a few surviving landscapes had been traced and were on view. The large bosky 'landskip' with a very luminous distance by George Smith of Chichester actually won the Society's award of £50 in 1760 for the 'best original landscape'; a fair choice it would seem, for the competition of Richard Wilson and Alexander Cozens does not appear to have been strong on this occasion. One of Richard Wilson's versions of the River Dee, lent by Mr. John Wyndham, is distinguished by the roseate glow suffusing the wooded bank and figures on the right, though the rather disappointingly thin paint has cracked a little with time.

Most conspicuous of the interesting prints and drawings was William Newton's regular classical design for an Academy of Arts and Science, a collegiate arrangement surrounding a courtyard which, if carried into effect, might have found our Society in monastic proximity with the Royal Academy to-day. Other items, such as Mary Moser's water colour flower-piece, and the gilded casts of medals showing Thomas Pingo's concentration of symbolic essentials and rare refinement of relief, testify as much to the diversity as to the quality of those exhibits assembled in 1760. Nor were they then disregarded; for we read that though the room at the Society of Arts was open only for a fortnight, and closed in the afternoons to all but members, the Society sold 6,582 sixpenny catalogues—this charge only being levied to keep out a lawless and violent mob. The absorbing story of the artists' early struggles for wider recognition, their factions, and the foundation of the Royal Academy, is related in W. T. Whitley's *Artists and their Friends in England, 1700–1799* (1928) and in Kenneth Luckhurst's *The Story of Exhibitions* (1951).

NEVILE WALLIS

THE NATIONAL ACADEMY SCHOOL OF FINE ARTS, NEW YORK

Even after the American Colonies had separated from England, those opulent citizens who had cultural and social aspirations continued the traditions of the mother country and looked to it for guidance. Portraiture, as the indication of family distinction, continued the tradition of the aristocracy in England. Its artists travelled to England to study. Indeed, Benjamin West, who had attained some success as a painter in Philadelphia, early moved to London; there he was one of four artists who submitted a plan for the Royal Academy to King George III in 1768. He was elected its second president in 1790. As West was court painter to George III, his London studio was the Mecca of young American painters who sought his hospitality and guidance to further their study.

Among these in 1811 was Samuel Finley Breese Morse, who had gone to London with Washington Allston, whose student he was. He is known to history as inventor of the telegraph, but he was a great painter in his own right. In 1825, just after he had completed a full-length portrait of General Lafayette for the City of New York, he called a meeting of the artists of New York to form a Society for Improvement in Drawing, the first meeting of artists in the States to be held for the advancement of their profession. The result was the forming of the National Academy of Design, and Morse was elected its president. The National Academy was closely patterned on the Royal Academy of Arts. Like the latter, its two expressed objects were the establishing of 'a well-regulated school or academy of design for the use of students in the arts, and an annual exhibition open to all artists of distinguished merit'.

As in the Royal Academy, government is by a Council; the Council have the entire direction and management of the business of the Academy, but new laws and regulations must be sanctioned by the general assembly which meets on certain fixed dates. The number of academicians is fixed, and of course only professional artists are eligible as members. On election each member has to present an approved specimen of his work.

The National Academy has recently opened its new School of Fine Arts building at 5 East 89th Street in New York. Designed by William and Geoffrey Platt, architects, the half-million dollar structure is the first new school building devoted to the teaching of drawing, painting and sculpture to be erected in the metropolitan area since the turn of the century. The new air-conditioned studios provide for an enrolment of five hundred students.

A feature of the first floor is the Assembly Room; it will accommodate two hundred people for lectures and meetings. This room, panelled in cherry, also contains the Academy's library of over four thousand art reference books and a selection of historical paintings and sculpture from its permanent collection. The faculty of the school are the painters Robert Philipp, Leon Kroll, Douglas Gorsline, Dean Cornwell, Louis Bouche, Ernest Fiene, William Auerbach-levy, Mario Cooper, Ivan G. Olinsky, Eric Isenburger, and John C. Pellew, and the sculptors Carl L. Schmitz, Jean De Marco, Anthony de Francisci, Paul Fjelde, Adolph Block, and Joseph Kiselewski, all members of the Academy.

At the last meeting of the Council, Sir Charles Wheeler, Sculptor, and President of the Royal Academy of Arts, was elected an Honorary Corresponding Member of the National Academy of Design.

JOHN F. HARBESON,

President, National Academy of Design

'SWEDISH TEXTILES FOR MODERN LIVING'

An exhibition devoted to 'Swedish Textiles for Modern Living' will be on view at the Ceylon Tea Centre, Lower Regent Street, London, W.1, from 21st April until 7th May (admission free). It has been arranged by the Swedish Institute for Cultural Relations in co-operation with three leading Swedish textile manufacturers. Some twenty Swedish designers will be represented, including Mrs. Astrid Sampe, Hon.R.D.I., who has also helped to design the exhibition. In addition to curtains, hangings and table-linen, a number of carpets will be displayed.

The exhibition will subsequently be shown in Manchester (15th September to 8th October), Glasgow (17th October to 5th November), Edinburgh (11th November to 2nd December), Coventry (10th to 31st December) and other centres in this country.

OBITUARY

MAJOR W. H. CADMAN

Major William Henry Cadman, M.B.E., B.Sc., F.R.I.C., M.I.Chem.E., the noted research chemist whose discoveries greatly facilitated the production of carbon black, died at Market Drayton on 20th February, aged 79. He was a Member of Council of the Society from 1943 to 1946, and a Vice-President from 1947 to 1950.

Cadman was the third son of James Cadman, a well-known mining engineer. Like his brothers (the eldest of whom, the first Lord Cadman, is commemorated in a biennial lecture to the Society) he showed a natural gift for scientific inquiry. He graduated B.Sc. from the University College of North Wales, and from 1905 to 1914 worked in the service of the Egyptian government. In 1915 he was severely wounded in action at Gallipoli, and was subsequently appointed to the staff of General Allenby in the important posts of Assistant Chemical Adviser and Commandant of the Central Gas School at Rata. After the war, Cadman was for a time Professor at the Higher College of Agriculture, Giza, before joining the Anglo-Persian Oil Company as chief research chemist. He established a laboratory in the Persian oilfields at Maidan-i-Naftun, where his investigations showed that carbon black (or colloidal carbon, as he preferred to call it) equal in quality to the best produced in America could be made from the petroleum product, natural gas, for long treated as a waste product. In 1930 Cadman was transferred to the Anglo-Persian head office in London, where he directed the increasing production of carbon black made possible by his discoveries, and also research into the extraction of oils from coal and shale.

During the Second World War, he was Commandant of the Eastern Command Central Gas School, and was appointed M.B.E. for his services in this connection. He also served on the Technical Force of the British Intelligence Sub-Committee which penetrated into Germany at the heels of the advancing Allied Armies to investigate the manufacture of carbon black by the Germans.

Whilst a Member of the Society's Council, Cadman found much to interest him at meetings of the Society, to which he made many contributions—in particular, a paper on 'Colloidal Carbon' (*Journal*, Vol. XCIV, p. 646) which drew on his unsurpassed knowledge and experience of this essential material of industry.

SIR GILES GILBERT SCOTT

Sir Giles Gilbert Scott, O.M., R.A., PP.R.I.B.A., who died in London on 8th February at the age of 79, was awarded the Society's Albert Medal for 1949 as 'Builder of a lasting heritage for Britain'. By his achievements he invested with fresh

distinction and significance a family name that for over a hundred years, and in three successive generations, has been eminent in English architecture.

The second son of Sir George Gilbert Scott (and grandson of Sir Gilbert Scott, who designed the Albert Memorial), Giles Gilbert Scott won recognition at an earlier age than either of his forbears. He was only 22, and very recently established in independent practice, when his design for Liverpool Cathedral was selected from among more than a hundred others. During the early period of construction he worked in collaboration with G. F. Bodley, but after the latter's death in 1907 the cathedral became the responsibility of Scott alone, and it is his monument.

Giles Gilbert Scott's other major works of church architecture included St. Paul's, Derby Lane, Liverpool, the Church of the Annunciation, Bournemouth, and the War Memorial Chapel for Charterhouse School. Of his secular buildings, the most important are in London,—where he designed the new Waterloo Bridge and the electric power station on Bankside, and restored after war damage both the Chamber of the House of Commons and the Guildhall—and in Oxford and Cambridge. He designed new libraries for both universities, and made additions to the college buildings of Magdalen and Clare.

Scott was elected R.A. in 1922, and three years later received the Royal Gold Medal for architecture. From 1933 to 1935 he was President of the R.I.B.A. He was knighted in 1924 and appointed to the Order of Merit in 1944.

MR. THOMAS GIRTIN

Mr. Thomas Girtin, M.A., D.Litt.(Hon.), who died on 7th March, aged 85, was Senior Past Master of the Worshipful Company of Clothworkers, and a former Governor of Girton College, Cambridge. His work for education included service to the University of Leeds, the City and Guilds of London Institute, and this Society. He became a Life Fellow in 1935, and as representative of the Clothworkers Company was a member of the Society's Examinations Committee from 1949 until 1956.

Girtin was by profession a metallurgist, but it was as a student and collector of English water-colours that he made his mark. He was a direct descendant of the water-colourist Thomas Girtin, and in collaboration with David Loshak produced, in 1954, a definitive work on that artist. He was also partly responsible for the valuable catalogue of drawings by J. R. Cozens which appeared in 1935. Girtin and Cozens were splendidly represented in his own collection, which, by virtue of the number and quality of the works it contained, may be regarded as one of the most important remaining in private hands.

CORRESPONDENCE

THE JACQUARD LOOM IN 1820

From *Sir Ernest Goodale, C.B.E., M.C., a Vice-President of the Society.*

I was extremely interested to read, 'From the Journal of 1860' in the issue of February last, the extract from Peter Le Neve Foster's paper 'On Figure Weaving by Electricity'.

As Chairman of a company producing figured fabrics on hand and power looms fitted with Jacquard mechanisms, I find anything about this great Frenchman absorbing. Basically, the principle of selecting the warp threads to be raised for each throw of the weft shuttle is still the same to-day as when Jacquard conceived it.

It is true that, as is not unusual, an improved mechanism was at first bitterly opposed, but it is on record that six years after his invention was declared public property in 1806 and Jacquard was rewarded with his pension and a royalty on each machine, there were already 11,000 Jacquard looms in use in France.

I wonder what Mr. Le Neve Foster meant about 'the increasing competition from the English'. This would not seem to be from a readier adoption of the so-called Jacquard loom, because by 1820, it would seem, its operation was still unknown in England.

Among the late Sir Frank Warner's papers (he was a member of Council of this Society from 1917 to 1930), I found an original letter dated from Paris 3rd August, 1820. I enclose a copy. It is addressed to Messrs. Lea, Wilson & Co., of 26, Old Jewry, London, and is signed by a 'Thos. Smith'.

As far as I am aware this letter, which would appear to be a 'spy's' report on the Jacquard machine, has not been published hitherto. The postscript contains a very human touch on the vagaries of travel in France some 140 years ago.

The street directory for 1820 in the Guildhall Library describes Messrs. Lea, Wilson & Co. as 'Silk & Bombazeen Manufacturers'.

PARIS, Aug. 3, 1820

SIR,

I wrote you very hastily on Saturday and with the imperfect knowledge I then possessed thought it better to wait an answer to know if you had any further instructions. Since then I have had admission through the help of Mr. Ferot into one of the largest manufactories in the environs of Paris, for here the manufacturer has his warehouse in the City and his factory in the suburbs—I have here seen the beginning, the middle and the end of the process—the reeding-in—the stamping of the pasteboards—the tacking of them together—I have seen them at work—I mounted a platform and looked into the very bowels of the machine—and have also seen and handled its separate parts. The Proprietor of the machine was extremely civil, nay polite. I got what information I could from him—after that I got Mr. Ferot to hold him in conversation while I took the Foreman apart—he was more polite and communicative even than his master. He is a Lyons man—a clever fellow and thoroughly understands his business. He set various men to work to satisfy me and after having detained him an hour I offered him a five franc piece—he would not accept of anything for himself but intimated the men would.

Here they were making Cashmere shawls and imitations of them— a man sits to the loom with a boy on each side on the same seat, he treads the treadle and beats the batons and the boys shoot the shuttle—they work at the borders and then drive the shuttle across the whole width. There is *only one* shoot under a lash. Some are worked with a ground harness and some not. Upon the top of these looms are three machines sometimes at work at the same time—one for the border, one for the end and the last for the corners if there are any—of course. There are three treadles and three leavers, one for each machine. The state of perfection and neatness of these looms, and the regularity with which they work is surprising—There is something very alarming in the appearance of the whole together. The eye sees so much tackling at once—but upon examining it piece-meal difficulties vanish. I am now making drawings from recollection—and I doubt not of being able of conveying to you a perfect knowledge of this machine which is the glory of France, and if we are enabled (which I doubt not) of introducing it in England, will form a new era in the history of English weaving, and I trust will amply repay you for the trouble, anxiety, and expense that you have been at. I respectfully beg to state I never spent more anxious days than I have at Paris—for at one time there seemed no hope of my procuring a sight of these machines at work. The little weavers do not possess them—I went to the great ones—but I had no letter of introduction. Imagine a Frenchman in London upon the same errand and without friends there—asking you or any other manufacturer to show his premises—to exhibit and explain a process that was highly valued—for which the inventor was receiving an annuity as a reward for his

genius—add to this these premises where this process was carried on was at a considerable distance—would the London manufacturer leave his business for to gratify the curiosity of the unknown foreigner, especially when he reflected that it might be an injury to his country?—indeed at some places I got quite a reproof. Mr. Ferot gave me very little hopes but on him I fastened like a leach [*sic*]. Every morning I was with him. Indeed I think (as you supposed) that he was too much of a Frenchman to wish me to see it—he spoke fairly—and though I know he was refused at some places, yet I thought he did not do his utmost. Achilles was vulnerable in his heal [*sic*], tradition says, and every man is like him—there is one part at least which can be made to feel—I told him that the impression on your mind was that he could procure me a sight of one if he would, and if he did not you would consider that he would not, and so on. The next day he told me he thought he should succeed—he was to have an interview with a manufacturer on the following morning—and the next morning at 8 o'clock we took a fiacre and all three went to his Factory. I have obtained the prices of silk furnitures, one and 2 colours, and also cords. I have also obtained some patterns—ribbons here are a sort of plaid—nothing else is worn. I have got some of them. I have also obtained a *Hook* as you desired—and also a small bit of the Pasteboard to shew its texture.

I am, Sir,

Your obedient Servant,

THOS. SMITH.

I expect to be in London Monday night—to Mr. Dickie, Betterton, Ward, &c. I should like to be remembered—Cashmere scf. here 5/4 wide 2–⅞ long—handsome 430 f. Shawls 6/4 scf. 235 fr. I gave you in my last letter the price of a Carriage at Calais—but forgot to say there was no carriage they would let fit for an English gentlemen to travel in.

To: Messrs. Lea Wilson & Co.,
26, Old Jewry,
London.
(Mr. S. Wilson)

NOTES ON BOOKS

SCIENCE IN INDUSTRY—POLICY FOR PROGRESS. *By C. F. Carter and B. R. Williams. Oxford University Press,* 1959. 21*s net*

Perhaps because of the small part which the scientist played in the industrial revolution in Great Britain, a close relationship between science and industry has developed more slowly in Britain than in the other major industrial nations. Now the nation is faced with an increasing degree of industrialization in many of its traditional markets, weakening its position as an exporter of general technical products, but placing a premium on the more sophisticated industrial techniques which cannot be acquired as readily as can established processes. The special position of the scientist as an adviser to industry, and the rapid and intelligent assimilation by industry of scientific discovery, are therefore both matters of remarkable importance.

In *Industry and Technical Progress* and *Investment in Innovation,* Professors Carter and Williams attempted an analysis of the conditions that determine the rate of application of new scientific and technical knowledge in British industry. Now, in their third report to the Science and Industry Committee of the British Association for the Advancement of Science, who, in combination with the Royal Society of

Arts and the Nuffield Foundation, were the sponsors of this research, they put forward their proposals for improvement.

Because of the difficulty of arriving at a commercial decision in relation to research and development expenditure, there is a general tendency for those industries which are not science-based to regard these matters as the province exclusively of the Government bodies and industrial research associations. In the first part of their report the authors discuss what action industry should take to help itself; and they suggest that the pursuit of a speedy technical progression is not necessarily the concern only of the few very large firms able to allocate funds to basic research projects not immediately related to their existing commercial outlets. Any firm, whatever its size, can improve its chance of keeping pace with technological development by increasing its awareness of what is taking place in related fields and encouraging and improving the receptivity for new ideas of its management. The authors discuss this problem of communication, and put forward many helpful suggestions that will greatly assist those wishing to review the problem as it occurs within their own organization.

Probably the first part of the report will be of greatest value to the firm rather above average size, say employing over 250 people, which is attempting to formulate a development policy bringing together a number of unrelated projects now scattered over several departments of its works.

The authors suggest that, before taking a decision on research and development policy, the firm should assure itself that there are not techniques of management other than research which require attention, and which might produce more immediate technical and financial advantages. Rightly they make no apology for listing such matters as work study, production planning and control, budgetary control, costing, and market research. The small amount of thought which is given to these essential management techniques throughout industry must have led the authors to despair of their rather more esoteric subject ever being understood or appreciated.

With these basic tools available, the firm should be able to proceed with greater confidence to make use of the admirable guidance offered on matters concerning decision-taking and the day-to-day management of research and development projects.

It is when dealing with matters within industry that the authors are most helpful; but there are times when one wishes that they had not set such a wide interpretation on their terms of reference. A more detailed investigation of the cost of research, both pure and applied, supported by comparative figures drawn from firms in various industries and having a reputation for successful innovation, would possibly be of greater value than the rather too general survey of the problem of higher management, its recruitment and training.

In their policy proposals for government action, it is possible that the time devoted to the study of the problems of taxation, credit policy, tariff and restrictive practices—all matters which have recently been the subject of, or are still undergoing, close scrutiny—could have been even more profitably employed in a closer examination of government policy in relation to research and to education. Although it might be trespassing on ground already covered by the Carr Committee, an appreciation of the apprenticeship schemes in use in West Germany and Switzerland would also seem appropriate in view of the serious shortage of technicians in industry, which is greater just now than that of graduate scientists.

The problem of a closer understanding between those concerned with administration in industry and commerce and those involved in advanced technology is unlikely to be eased until there is a greater scientific content in general education; but, until this is brought about, works such as these admirable reports will greatly help the administrator and the specialist to understand each other's point of view.

PIERCY

MODERN ARCHITECTURE IN BRITAIN. *By Trevor Dannatt. London, Batsford,* 1959. 63*s net*

This book covers some fifteen years of architectural development in Britain since the end of the war. The period has confirmed the revolution of the post-war years that placed the programme as the guiding principle of architecture, but the struggle to make an architecture on a larger scale and with the fuller resources of industry has become intensified. This struggle concerns still only a limited number of the total of all architects practising, but these, stemming from the original pioneers, deal with architecture not as a separate art, but as an activity leading to some general solution of the problem of contemporary living, and it is no accident therefore that their chief work has lain in housing as it merges into town planning, and with schools.

The school programme has a particular interest because of its direct involvement with industry. The history of the Hertfordshire school programme is a tribute to the value of co-operation and group working. But it also discloses some limitations of industry and of a modular system of prefabrication; the limitations of having to use the particular products of particular firms exclusively in any one building, and the limitations on the prospect of any strong rhythm emerging where repetition of prefabricated units constitutes the economy of the system.

The window wall, which is a by-product of the Hertfordshire school approach, has had an unfortunate effect upon architecture from which there is now a strong reaction in favour of the weight and consequence that it lacks. It is a criticism also of the schools that, placed amid the heavy foliage of countryside or park, they look unsubstantial.

What these architects have done to mitigate these deficiencies is admirable. At close range they are full of human touches, and the contributions of mural painters and sculptors opens new vistas to the oncoming generations.

Under the leadership of the London County Council housing has pressed forward to really comprehensive solutions of urban living in which the interest is divided, as it should be, between the disposition of large areas of living space—the balance of sun and shade, of green and paved space, of access and leisure space—and the architecture of the various units of building involved. The architecture of housing may vary from the formalism of Tecton and Lasdun to the strong reaction from industrialized materials of Sirling and recent L.C.C. work, but its concern is to offer a total conception of urban living, and this is architecture's chief contribution to life.

Set beside these two activities the great effort of the new town programme seems to have wasted itself in acceptable decency, as may be seen in comparing the town centres of any new town with the aerial view of the L.C.C. Alton Estate on page 131. The sad fact has to be stomached that the new towns are neither new nor towns, and their centres, though they contain the germs of new ideas about town centres, are insufficiently bold and completely out of scale with the rest.

This covers the chief of what we have had to say in this period. Other countries, supposedly less well off than we, have built great stadia, stations, theatres and a grandiose paraphernalia of transport architecture. We have concentrated on housing, schools and our sweet new towns; which means that our bankers and business men and our city fathers generally continue on their unregenerate ways as though nothing much was happening in the world. Can nothing move them?

This book shows on the other hand that something definite is happening and shows it, as one would expect from Trevor Dannatt, more than well. The photographs, the page design and typography are better than Batsford has ever before achieved, and the whole production, with Sir John Summerson's penetrating and witty introduction, rises to a subject that deserves nothing short of the best.

E. MAXWELL FRY

ROYAL PAVILION: AN EPISODE IN THE ROMANTIC. *By Clifford Musgrave.* 2nd edition, revised. *London, Leonard Hill,* 1959. 50*s* *net*

The history of the romantic movement, by an apparent paradox, is inextricably bound up with neo-classicism. Indeed, the neo-classic movement itself should perhaps be regarded as the earliest stirrings of romanticism rather than the final phase of renaissance classicism as it is conventionally viewed. Even at their most austere neo-classic artists were really using classical motives in a romantic way. They were concerned with the associational or picturesque aspects of elements taken from the classical world rather than with its spirit.

Nothing could better illustrate the ease with which the transition from the one mode of expression to the other was made than the history of the Pavilion built by George IV at Brighton, here told (in a revised and considerably expanded form) with such a loving wealth of detail by Mr. Clifford Musgrave, who has been in charge of the building for more than a decade. Prinny's original conception was a sea-side *palazzino* in the French neo-classic manner, the English version of the *style etrusque* that Holland had used at Carlton House. Holland's first exterior for the Pavilion was in a conventional 'Regency' classical style; its interior decoration seems to have been in the French neo-Pompeian idiom. Lignereux, one of whose designs for the Grand Saloon Mr. Musgrave has discovered, was a leading Parisian *marchand-mercier* and a purveyor of all that was smartest in the ultra-classical Louis XVI style of the day (and not a cabinet-maker, as Mr. Musgrave suggests in one of his rare errors of fact).

But the French Revolution and the Napoleonic wars upset all this, for in 1805 the Prince told Lady Bessborough that he decided to transform these neo-classical interiors into the Chinese style simply 'because at the time there was such a cry against French things, etc., and he was afraid of his furniture being accused of Jacobinism'. The catalytic agent which actually brought about the new choice of style seems to have been the gift of several lengths of particularly fine Chinese wall-paper. From the moment he began to use these the Prince of Wales pursued his Arabian Nights dream with characteristically romantic enthusiasm, continually extending, altering and improving the Pavilion both outside and within for a quarter of a century. In the end he really succeeded (with the expenditure of over half a million pounds) in producing an immensely significant romantic monument of architecture, a building uniquely splendid in its own kind.

It was not to be expected that its wildly exotic romanticism would appeal to Queen Victoria, but it was a tragedy that its contents were removed and the interiors extensively damaged before the Brighton Town Commissioners (with extraordinary enterprise for the period) acquired it in 1850. After nearly a century of starved budgets, misunderstanding of its nature and consequent neglect, the Pavilion is at last beginning to regain something of its former splendour. That this has happened since the last war is partly owing to the present enthusiasm for the Regency style and partly due to the passionate interest and care which the present curator and his brilliant technical assistant have devoted to restoring the interiors. But it also owes much to the great generosity of recent monarchs (and especially to the present sovereign) in returning many of the furnishings removed by Queen Victoria. In the last decade the principal rooms have begun once again to resemble those sumptuous interiors in which the First Gentleman of Europe entertained the flower of European society in the years following the Congress of Vienna and which the author of this fascinating book evokes so vividly. But much remains to be completed both in the way of redecoration and refurnishing. The greater part of the original fittings still survive and doubtless, as time passes, more will gradually return to their original home. It is profoundly to be hoped, however, that even should the new Betting Bill permit it, the Brighton city-fathers will not prejudice the completion of the restoration

by converting this historic building into a Casino, as has been recently proposed in the press. After such enterprise as Brighton has displayed in first acquiring and latterly restoring this important historic monument, that would indeed be a sorry ending to the story.

F. J. B. WATSON

A SOCIAL HISTORY OF THE NAVY 1793–1815. *By Michael Lewis. London, Allen & Unwin,* 1960. 42*s net*

From his earlier memories, Professor Lewis recalls that, until less than half a century ago, what people spoke about as 'the Great War' was the stretch of hostilities with Revolutionary and Napoleonic France which, with two short intermissions, spanned the years between 1793 and 1815. It was a 'great' war indeed by any standard but the present, and it saw the British Navy at a peak of renown under such admirals as Howe, Samuel Hood, St. Vincent, Cornwallis, Duncan, Nelson and Collingwood. It was a Service as unique as it was curious, but it was a world on its own, where the 'landman' or 'lubber' was apt to be confused.

It is this belligerent period which Professor Lewis has chosen as his sphere for inquiry—not its naval actions, which figure prominently in his own *History of the British Navy*; not its guns and tactics, of which he has treated in *The Navy of Britain*; not even the higher direction of fleet strategy, but recruitment, constitution, and the human element. The questions he has set himself to answer are: What were the ranks and responsibilities of officers and men? From which strata of society were they drawn? How did they rise? How were they rewarded? What was their fate? Long and important asides give analyses of such matters as ship losses—a very small proportion, incidentally, being due to enemy action. Health, discipline and amenities are also discussed.

The facts on which Professor Lewis's conclusions are based are often to be found in the long series of publications of the Navy Records Society, rich in source material of every kind, and in two major biographical compilations to which many students of the period turn for information: Marshall's *Royal Naval Biography*, published in 1823, and O'Byrne's *Naval Biographical Dictionary* of 1849. Both Marshall and O'Byrne were in time to catch at least the echoes of heroic events, using records put together by elderly survivors, whose imagination sometimes embellished the autobiographical chronicles which they supplied by request.

The author has made such thorough use of Marshall and O'Byrne that it is hard to see how they could have been squeezed further, and to fitter purpose, in order to give the reader a picture of a series of typical careers, and to present a fleet in its entirety, complete with its strict traditions, its often bland defiance of official regulations, its rigidity of custom and sometimes of thought, its pragmatism, and its happy ability to make the most of a series of oddities in nomenclature and indeed in actual rank which must still puzzle all but the most attentive.

It is all so well put together that it would be pleasing if other professions, the Church, the Law, Medicine, the Army, could be treated, historically, in a similar way. Professor Lewis never over-loads, never ventures into windy speculation, never wanders from the point. In fact, by concentration and by unfailing clarity he presents a survey of a peerless body of men which is complete in its persuasion.

It is certain that the Navy which in two later and much fiercer wars saved this country from defeat, and enabled her to progress from defence to attack and so to victory, owed as much to the Navy of the late eighteenth and early nineteenth centuries as to any other 'imponderable' factor. That earlier Fleet laid the foundations of what Mahan called 'combat supremacy', which is the most covetable attribute any armed service can possess. Its affairs have general as well as specialist interest, and Professor Lewis writes with kindly awareness of a lay public.

OLIVER WARNER

BRITISH RAILWAY HISTORY—AN OUTLINE FROM THE ACCESSION OF WILLIAM IV TO THE NATIONALIZATION OF RAILWAYS. [VOL. II] 1877–1947. *By Hamilton Ellis. London, Allen & Unwin,* 1959. 35*s net*

To attempt to compress into 860 pages the complex history of the railways of Britain, from their first beginnings in 1830 to the end of their independence in 1947, is a task that might well daunt the most energetic of historians. Yet in his two volumes of *British Railway History*, Hamilton Ellis has faced the task and has carried it to completion with a thoroughness and a competence that are both wholly admirable. It is the second volume which is now under review.

There are more ways than one of compiling a history. The historian who has a vast mass of material to compress into a relatively small space is sometimes reduced to a dry recital of facts, dates and figures. Nothing of that kind would content Hamilton Ellis. Compressed or not, his history lives, and he knows the art of selection, whereby the events and personages that had the greatest influence on British railway development have been given their due prominence. Many readers, too, will derive pleasure from the humorous turns of phrase and penetrating comment with which the author from time to time enlivens his historical record.

This second period of British railway history begins with the railway network largely complete, and therefore contains relatively little of the excitements of earlier years, when rival schemes prompted desperate counter-measures, even to the extent at times of physical violence. Nevertheless the old antagonisms flared up as Sir Edward Watkin, last of the line of railway dictators, endeavoured by fair means or foul to build up a railway empire extending from Lancashire to the mainland of Europe. Assuming between 1864 and 1872 in succession the Chairmanships of the Manchester, Sheffield & Lincolnshire, South Eastern and Metropolitan Railways, and being also a prime mover in the Channel Tunnel project, he came into collision first with James Staats Forbes of the London, Chatham & Dover, initiating a strife, with no holds barred, that continued for thirty years between that company and the South Eastern.

Then, when at last in 1893 Watkin got his Bill through Parliament to link the M.S. & L. at Annesley, north of Nottingham, with the Metropolitan at Quainton Road, by 94 miles of new main line, it was in the teeth of the fiercest opposition from the London & North Western, Midland and Great Northern Railways, with all of which at various times in earlier years the M.S. & L. had 'flirted'. But he did not live to see the two extremities of his 'empire' thus linked together; neither did those who provided the finance for the costly London Extension see the 6 per cent return on their investment that he had confidently promised. With the change of the company's name from Manchester, Sheffield & Lincolnshire to Great Central, the wags of the time declared that 'Money Sunk and Lost' had merely been exchanged for 'Gone Completely'.

Many other notable personalities come into the story. There is Sir Guy Granet, for example, the lawyer whose wily acquisition for the Midland Railway of the London, Tilbury & Southend, under the very nose of the unsuspecting Great Eastern, led to Lord Claud Hamilton, the G.E.R. Chairman, sacking his General Manager, and summoning Henry Thornton from the U.S.A. to take charge of Great Eastern affairs in 1914. There is also William Whitelaw, the tenacious Scot who fought the Ministry of Transport, and its first Minister, Sir Eric Geddes—himself an ex-railwayman, though now completely hard of heart so far as railways were concerned—to obtain financial justice for the badly run-down North British Railway after the 1914–1918 war. Not surprisingly, Whitelaw's success prompted his selection to become Chairman of the newly-formed London & North Eastern Railway in 1923. It is intriguing to speculate how the L.N.E.R. might have developed had the forceful

Thornton rather than Sir Ralph Wedgwood been appointed its Chief General Manager, with the brilliant Sir Nigel Gresley as Chief Mechanical Engineer.

Mention of Gresley brings its reminder that Hamilton Ellis has not been content to confine himself to the major matters of railway planning, building, amalgamation, competition, antagonism and intrigue. Thus the three chapters of this volume headed 'Mechanical Development' give a concise review of the changes from 1877 to 1947 in the design of locomotives and rolling stock, freight handling, signalling, architecture and many other realms. No Ellis book would be complete without an encyclopædic index, and the 18 pages so taken up in this volume add greatly to its value as a work of reference.

CECIL J. ALLEN

SCIENTIFIC MANPOWER. *By Joyce Alexander. London, Hilger & Watts*, 1959. 15*s net*

The British Association for the Advancement of Science (later joined by the Royal Society of Arts) in 1952 set up a Science and Industry Committee to examine the factors which determine the rate and way in which scientific discoveries are adopted in British industry. Mrs. Alexander was a member of its research staff, and the book is the outcome of her particular concern with the problem of shortage of scientific and technological manpower.

The book gives a survey of the numerous reports up to 1957, but has been overtaken by events, and especially in its year of publication. Thus it lacks the accuracy of the 1959 Scientific Manpower report of the Advisory Council on Scientific Policy, while the Crowther Report '15 to 18' provides ample statistical evidence of problems and shortcomings to which Mrs. Alexander makes only general reference. Such are the hazards of publication in a period of rapid change, but the book is by no means free from avoidable blemishes.

The picture given of technical education is quite inadequate and takes practically no account of the emergent four-tier structure of local, area and regional technical colleges, and the colleges of advanced technology as affecting manpower training at different levels. Moreover, the relative contribution of the colleges as compared with the universities in producing technologists is not adequately conveyed, whereas the ratio is about 5 to 1. Again, for example, at least 60 per cent of the corporate members of the Institution of Mechanical Engineers have come *via* the technical colleges. The final chapter of summary and conclusions is preoccupied with the eleven-plus examination and university entrance requirements, and even the section on leaving school hardly mentions the technical colleges.

Certain confusions in terms and functions are to be regretted: for example, sandwich courses are listed on page 9 as part-time study instead, presumably, of 'block-release' courses. The fact that sandwich courses are then stated to comprise full-time education and full-time training, does not remove this prevalent and unfortunate misconception, e.g., page 121. Again, there is the totally inaccurate and damaging statement that 'the Higher National Certificate is approximately of University Intermediate standard' (page 10), whereas it reaches pass degree standard in the subjects taken. Moreover, O.N.C. not H.N.C. is the standard of entry to a Diploma in Technology course.

The most interesting chapter is on scientific womanpower, but it accepts the present position far too complacently, and even advises 'headmistresses to develop some spirit of humility in their pupils' (so as to enable) 'them to realize that in the world of industry they may be regarded as second-class citizens'. It is not surprising, therefore, to find that Mrs. Alexander refuses to look closely at the Russian scene—'These comparisons always seem somewhat pointless as we are referring to two quite different forms of society'. From visits made to their top technological institutions and to various industries, the reviewer knows something of the contribution of Russian women in their work, and these provoke, not a wish slavishly

to follow all Russian methods, but certainly more critical analysis and constructive recommendations than this book provides.

Not unnaturally, with such a complicated and far-reaching topic, this small book suffers from undue compression and lacks reality or balance accordingly. Thus technical training in other countries is covered in eight sentences on pages 47–8, while Scotland ranks at two brief paragraphs. For a useful survey there should be more room to deal more adequately and constructively with the many important aspects of this problem, including developments in foreign countries and a critical analysis of the social factors involved.

P. F. R. VENABLES

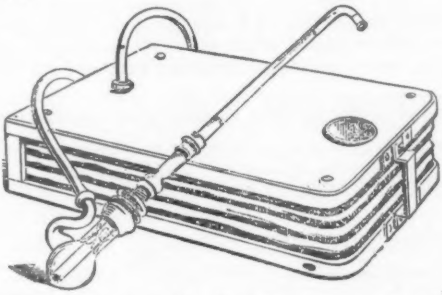
FROM THE JOURNAL OF 1860

VOLUME VIII. *6th April*

'PHILOSOPHICAL' AND SCRIPTORY APPARATUS

From the Catalogue of the Twelfth Annual Exhibition of Inventions, held at the Society's House in the spring of 1860.

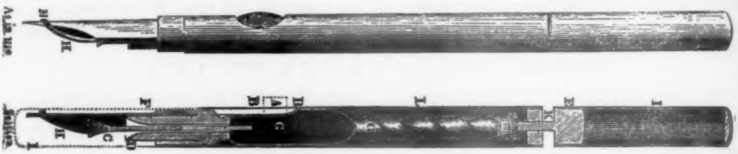
155. Patent Hydro-Pneumatic Inhaler; W. A. Tompson, 18 Cecil Street, Strand, W.C.



This instrument, which is easy of self-application, consists of four parts, viz., 1st. Self-inflating bellows worked with the foot. 2nd. A flask (for receiving the medicated fluid) which has a glass cylinder, traversed by about 16 capillary tubes, ascending from the bottom to the upper part of its perpendicular neck, where it is retained in position by a silver spring. 3rd. An adjusting apparatus which has a tube with a thread turned upon its outer surface to admit of its being more or less approximated to the top of the cylinder. 4th. A nozzle which has its remote extremity curved at a right angle with its shaft, and is furnished with a screw cup containing a disc of fine silver wire gauze. The nozzle being introduced to the back of the mouth, the opening of the bellows is to be covered by the foot of the operator, and the air, impelled by his weight, will rush through the elastic tube into the flask, but, being unable to escape with equal freedom, owing to the relatively smaller opening between the glass cylinder and adjusting tube, which is regulated by turning the screw of the latter, becomes condensed, so as to raise the caustic or otherwise medicated liquid to the summit of the capillary tubes, whilst, at the same time, the air, which will have passed the above obstruction, has acquired increased space for its expansion and, exercising its property of elasticity, removed any impediment to the ascent of the fluid. It will thus be seen that the supply of liquid, which regulates the fineness or coarseness of its final dispersion, depends upon the difference between the ingress

and egress openings of the flask. The liquid (carried by a strong atmospheric current) has now been traced to the nozzle, along which it passes to the gauze disc at its extremity, whence it is discharged upon the diseased surfaces in a minutely-divided and misty spray, and thus passes through the opening of the glottis during inspiration, without causing the slightest inconvenience to the patient.

255. Patent Fountain Penholders; John Moseley and Son, 17 & 18 New Street, Covent Garden, W.C.



These penholders are chiefly made of vulcanite. The reservoir, G, is made of elastic india-rubber. This is fastened to a top piece, which, being turned round to the left-hand, expels the air. The mouth of the reservoir is then dipped into the ink, and held there whilst the top is turned back. The elastic tube then recovers its tubular form, and fills with ink; a stopper fits into the mouth of the reservoir and prevents the escape of ink in the pocket. The ink is supplied to the pen by pressing the elastic tube at the finger-hole. The tongue, at the end of the stopper, C, is one of the most recent improvements, and by means of it a larger supply of ink is held in the nib of the pen.

Some Activities of Other Societies and Organizations

MEETINGS

FRI. 1 APR. Engineers, Junior Institution of, Pepys House, 14 Rochester Row, S.W.1. 7 p.m. T. A. L. Paton : *The Kariba hydro-electric scheme on the river Zambesi.*

MON. 4 APR. Chemical Industry, Society for, 14 Belgrave Square, S.W.1. 6.30 p.m. Dr. J. A. Kitchener : *The physical chemistry of foaming.*

Engineers, Society of, at Geological Society, Burlington House, W. 5 p.m. A. E. Bingham : *Research testing.*

Transport, Institute of, at Banqueting Hall of the Fishmongers' Company, London Bridge, E.C.4. 5.30 p.m. R. Stewart MacTier : *The future development of merchant ships.*

TUES. 5 APR. Civil Engineers, Institution of, Great George Street, S.W.1. 5.30 p.m. C. B. Townend : *The economics of waste water treatment.*

WED. 6 APR. Building Centre, Store Street, W.C.1. 12.45 p.m. W. H. Heywood & Co. Ltd. Film : *Light must fall.*

Engineers, Junior Institution of, at James Watt Memorial Institute, Gt. Charles Street, Birmingham. 7 p.m. L. W. Smith : *Industrial abrasives.*

Engineering Designs, Institution of, at Queen's Hotel, Birmingham. 7 p.m. H. D. Challen : *Developments in precision hollow forging.*

Newcomen Society, at Science Museum, S.W.7. 5.30 p.m. Rex Wailes : *Some windmill fallacies.*

THURS. 7 APR. Anthropological Institute, Royal, 21 Bedford Square, W.C.1. 5.30 p.m. Professor J. H. Pear : *Early relations between English anthropologists and psychologists.*

Interplanetary Society, British, Caxton Hall, S.W.1. 7 p.m. J. Allen : *Lunar missions and vehicle design.*

FRI. 8 APR. Engineers, Junior Institution of, Pepys House, 14 Rochester Row, S.W.1. 7 p.m. Louis Essen : *The atomic clock.*

MON. 11 APR. Royal Geographical Society, 1 Kensington Gore, S.W.7. 8.30 p.m. Anthony Forge : *Art and society in New Guinea.*

TUES. 12 APR. Mechanical Engineers, Institution of, 1 Birdcage Walk, S.W.1. 5.30 p.m. A. Fogg : *Performance testing of the complete car.*

WED. 13 APR. Building Centre, Store Street, W.C.1. 12.45 p.m. British Visqueen Ltd. Film : *Visqueen in building.*

WED. 20 APR. Building Centre, Store Street, W.C.1. 12.45 p.m. Building Research Station. Film : *The new V brick.*

THURS. 21 APR. AND FRI. 22 APR. Analytical Chemistry, Society for, at Church House, S.W.1. *Symposium on fertilizer analysis.*

FRI. 22 APR. Geographical Society, Royal, 1 Kensington Gore, S.W.7 5.15 p.m. George L. Hanssen and Richard W. James : *The economics of ship routeing.*

MON. 25 APR. Chemical Industry, Society of, 14 Belgrave Square, S.W.1. 5.30 p.m. Sir Harry Melville : *Ion exchange resins and their application.*

Geographical Society, Royal, 1 Kensington Gore, S.W.7. 5 p.m. C. W. Phillips : *The ordnance survey and archaeology.*

WED. 27 APR. Building Centre, Store Street, W.C.1. 12.45 p.m. D. Anderson & Son Ltd. Film : *Pyrodek roof construction.*

British Foundrymen, Institute of, Constitutional Club, Northumberland Avenue, W.C.2. 7 p.m. J. P. Graham : *Foundry coke production and utilization.*

THURS. 28 APR. British Interplanetary Society, at Hoare Memorial Hall of Church House, S.W.1. 7 p.m. Dr. E. W. Still : *High altitude chambers and pressure suits.*

OTHER ACTIVITIES

NOW UNTIL SAT. 16 APR. Battersea Central Library. Exhibition : *Georges Braque.* 30 reproductions.

NOW UNTIL SAT. 23 APR. Arts Council Gallery, St. James's Square, S.W.1. Exhibition : *The Epstein collection of primitive and exotic sculpture.*